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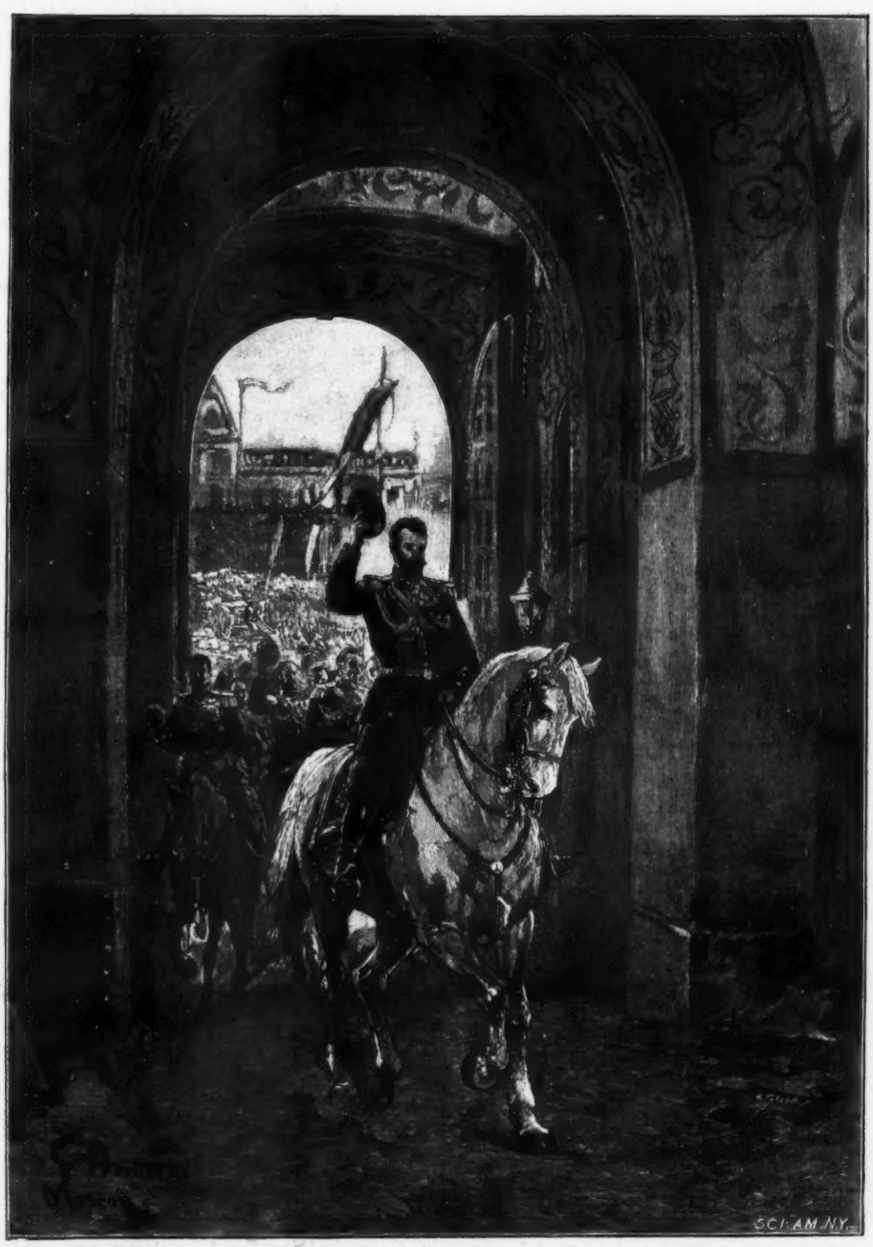
## THE CORONATION OF THE CZAR.

LAST week we gave an account of the ceremonies attending the coronation of the Czar; we now present two episodes of the great pageant. The great gates which pierce the wall of the Kremlin are of great interest, but perhaps none more so than the Holy Gate, which all must pass bareheaded out of respect for the venerated image suspended over the doorway. Our engraving represents the Czar removing his cap as he passed through the Holy Gate when the Czar and Czarina made their entry into Moscow from the Petroffsky Palace on May 21. They were met by the governor of the Kremlin at the Holy Gate and the imperial party then entered the Cathedral of the Assumption, where a solemn service was held. Our other engraving represents a halt in the state entry into Moscow. The Chapel of the Iberian Madonna, close to the Gate of the Resurrection, of the Kremlin contains a picture of the Blessed Virgin which is accredited with miraculous powers. Here their Imperial Majesties were met by the Metropolitan of Moscow and the Bishop of Mojaesk, and after kissing a crucifix and making the sign of the cross with holy water they entered the chapel and knelt before the sacred picture. For our engravings we are indebted to the Illustrated London News. In the current number of the SCIENTIFIC AMERICAN will be found some interesting views of Moscow and of the great procession.



THE CORONATION OF THE CZAR.—THE CZAR PASSING THROUGH THE HOLY GATE INTO THE KREMLIN.

[Continued from SUPPLEMENT, No. 1067, page 17062.]

## THE SENSES—THEIR USE AND CULTIVATION.*

Now it is quite evident that, just as our mental powers can be developed by education, so also can our senses. The newly born child is conscious of the stimulus produced by light, but he has no impression of objects, he has no peripheral vision. His sense of touch is strongly developed from birth, but he is without the sense of hearing till the second or third day, and possibly later. As the child grows up his senses become more developed and his intelligence increases; so it is with all of us: our senses and our intelligence go hand in hand and increase in powers of perception and conception until with advancing age they again become blunted. Some are, no doubt, endowed by nature with greater quickness of observation than others, but all can cultivate the powers they possess. About the middle of this century there appeared in London a Frenchman named Houdin, who had cultivated his powers of quick and accurate observation to a degree of perception that was hardly short of miraculous. His father had been in the habit of training his perceptive faculties from early youth by making his son walk down a street and then describe all that he had seen in the windows of the shops he had passed. Taking advantage of his exceptional quickness, the father professed that his son was gifted with second sight and made a handsome income by exhibiting his powers. One of his favorite tricks was to hold a seance in the drawing room of a strange house and to make his son give a description of one of the rooms on the ground floor, which room he had previously allowed him to glance into on his way through the hall. Houdin would accurately describe not only the furniture and ornaments of the room, but also the subjects of the pictures and the names of the books in the bookcase—all his information being obtained by one quick glance. The painter in the study of his art learns to distinguish gradations of color too subtile for the uneducated eye to perceive. He can resolve colors into their component parts, and when he wishes to reproduce the beauties of nature on his canvas he uses a number of pigments which to the uninitiated bear no relation to the general scheme of color. The musician, by long practice, can recognize the fundamental and overtones of every note; he can pick out the individual part in a complicated piece of orchestral work, and a false note made by a single instrument is immediately detected. The wine taster is, by long experience, able to value the different kinds of wine, either through the sense of taste or smell. So it is with the medical man, who is enabled to detect the slightest departure from the standard of health with a precision only born of constant practice and observation. The whole art of diagnosis, all success in treatment, depends on an intelligent use of our senses. Everything we know in medicine and surgery has been learned through the senses, and the greatest discoveries have been made by means of discriminate observation. The medical and scientific world is at the present moment mourning the loss of one of the greatest savants and experimenters of modern times; one who, by his genius, became pre-eminent as a chemist; one who saved for his fellow countrymen untold wealth, and who paved the way for the successful application of preventive treatment in medicine. I speak, of course, of Monsieur Pasteur, who, living to an advanced age, never seemed to tire of the role of benefactor to his fellow creatures. How was it done? By the constant and untiring use of the senses, by trained observation, and by well ordered experiments. We cannot begin too soon in our medical education to cultivate those senses which are to assist us so much in our profession. Anatomy was never learned by reading books; the only true way to study anatomy is by dissecting and seeing for one's self the complex arrangement of the human frame. Learnt in this way it is never, it can never, be forgotten. It was while dissecting as a student that Sir James Paget discovered the presence of the trichina spiralis in the diseased condition called trichiasis. And while I am on the subject of anatomy let me impress on you one thing, and that is to feel everything with your fingers as well as seeing it. Holden says that every surgeon should have eyes at the end of his fingers, so as to form a mental picture of what he feels, and every surgeon knows that when operating he has often to be guided by his fingers where, owing to bleeding or position, he cannot see. But unless he has learned by experience to recognize what he feels, his fingers will be of no use to him. So I cannot impress on you too strongly the importance of accustoming your fingers to the feeling of the normal parts and their relation to each other, and this experience you can gain in the dissecting room with very little trouble. Just as anatomy and physiology, chemistry and materia medica, and all those subjects which will take up your attention during the first two years of your studies—I say, just as these subjects lead you onward to the study of the greater sciences of medicine and surgery, so the habits of observation that you have acquired while mastering them become of infinite value to you when face to face with disease in the wards or the dispensary. Here, again, your efforts to acquire a habit of quick observation should be unceasing—eye, ear, touch, all the senses should be brought into play, first consciously, but with practice almost unconsciously. You may think that I am laying an unnecessary amount of stress on this point, but I assure you it is not so. From my own experience I find that a very large proportion of students notice nothing about their patients until they begin to interrogate them and to find out the history of their complaint. The patient possibly is lame, or his fingers are disfigured with rheumatic gout, or one of his eyes may be injured, but the unobservant student has seen nothing; not so with the practiced observer,

* Address delivered at St. Mungo's College, Glasgow, by Francis H. Napier, F.R.C.S.—From the Lancet.

who takes immediate note of any peculiarity of gait, posture, or figure, who hears the cough and notes its character, and takes in, almost insensibly, the nature and characteristics of his patient before asking him a single question.

In diagnosis there are two methods of procedure usually followed; one takes note of all the principal signs and symptoms of the patient, and afterward to elucidate the history of the case, and the other method is to reverse the process and begin with the history. The latter is the more generally adopted, as it is the easier, for the more salient features of the disease may often be discovered through the history without the trouble of any further examination; but whichever method is carried out, it is wise to begin by taking a rapid and comprehensive survey of your patient before doing anything else, for it is in the first few seconds that you will notice most. But let me warn you, on the other hand, against the evils of "snap shot diagnosis" which we are all of us so prone to in the earlier part of our career. These rapid observations of the outstanding features of a case should not be made the basis of an immediate diagnosis, but should rather act as guides to our subsequent examination, both physical and historical, of the condition of the sufferer.

Let me give you a few instances of what I mean. The man whose jaw is broken supports his chin on his hand; when the clavicle is fractured the shoulder on that side is flattened and drawn forward and inward, and the elbow is supported by the opposite hand to take off the weight. The peculiar swaying gait, the body being poised over each limb in turn at every step, betrays the condition called congenital dislocation of the hip, and the position of the limb makes us suspect the presence of hip disease in its early stage, the joint being flexed, abducted, and rotated outward into the position of greatest ease. A person suffering from inability to face the light, with watering of the eyes, compels us to think of disease of the cornea; but if these symptoms are confined to one eye, we suspect the presence of a foreign body or some local cause of irritation. The ataxic patient walks into the room with exaggerated movement of the legs, but he who is suffering from lateral sclerosis drags his stiffened limbs behind him. The complexion and appearance of the face may help us in many ways—it may be anæmic, chlorotic, flushed, cyanotic or jaundiced; it may be emaciated, puffed, or œdematous. These are only a few illustrations among a host that crowd into one's mind. Numberless instances might be quoted to illustrate the value of the cultivation of the senses in the practice of our profession. Take the case of tumors. The uneducated eye sees a swelling of a certain size and shape and nothing more; but the surgeon has to learn the nature of the swelling—he looks at the skin over it and at the vessels traversing its surface; he notes its color and the presence of inflammation or ulceration; his fingers detect whether the skin over the tumor is loose or bound down, whether there is fluid inside it, or, if solid, what its consistence; the hand applied to the surface detects increase of temperature or presence of pulsation, and the ear or stethoscope hears the bruit or sound within. All these points and more must be gone into before a satisfactory diagnosis can be made.

Even the most highly trained senses may be mistaken, and it should not be forgotten that a single sense may be wrong in its deduction, but that where several senses point to the same conclusion the evidence is much strengthened. We have all heard, and some of us may have had experience, of illusions of the senses, but we know that it is always a single sense that has been led astray; the ghost is seen gliding through the corridor, but there is no sound or footfall; the carriage is heard to drive up to the door, but no horses can be seen. An illusion never affects more than one sense at the same moment. Again, to take other instances, the educated fingers can detect the slightest deviation from the normal standard in the tension of the eyeball. The operator, by his cultivated sense of touch and exact balance of muscular action, is enabled to perform difficult and dangerous operations with comparative ease and safety. To such a pitch of perfection can this "tactus eruditus," or educated sense of touch, be brought that the surgeon, in passing the catheter or the lacrymal probe, can tell immediately if the point of his instrument is following a wrong direction, and is informed of the character of the mucous surface his instrument is traversing. I was told lately of a well-known surgeon who was exploring an incised kidney through a lumbar incision in order to discover the presence of a stone. With the point of his finger he was able to find it; and not only so, but he gave an elaborate description of the stone, its size, shape, and character, so graphic and so precise that his auditor could have drawn an exact representation of the calculus before he saw it.

Again, what should we know of the condition of the internal organs if it were not for our educated senses? Take the case of the chest—with the ear and the stethoscope we listen to the sound of the heart and discover the presence, character, and position of murmurs or periodical sounds; we listen to the lungs and notice the respiratory and pleural sounds and the vocal resonance. Inspection, auscultation, palpitation and percussion all give their quotum of information. And so on through the whole range of medicine and surgery. It is quite evident then that you cannot bring yourself too much in contact with patients and their diseases, and it is for this reason that you are much to be congratulated on the wealth of material ready to your hand. Here you will have no excuse for not cultivating those senses which in some other schools might become blunted for want of use. And let me strongly advise you not to depend on what your teachers tell you, but to depend on your own observation; during the next few years you will be under the guidance of many instructors, but all they can do for you is to teach you how to learn for yourselves; your teachers as well as yourselves are merely students, only a few rungs higher up the long ladder of knowledge; they are all liable to error, and it should be your constant care to correct such error by the constant use of your own observation. I do not ask any one of you to become a Sherlock Holmes; that most interesting person, who died in this country in the early spring, but seems to have come to life again in America, had a comparatively simple task before him; from an accomplished fact he had to trace back the sequence of events until by discovering the why and the wherefore he was able to put his finger on the perpetrator of the deed. We have a much harder task, for we must look forward as well as backward; not only must we find the first causes and trace the origin and course of a disease, but we must also discover the indications which point to its future progress either for good or bad. But it is not sufficient to haunt the wards and dispensaries. We have seen already that sensation is a mental quality; consequently the brain must be educated. It is not sufficient for the brain to be a simple storehouse of impulses received through the senses; it must also be educated in order to give these sensations their proper proportion and significance. Reading, and wide reading, must be resorted to, to develop the mind and give it a broad grasp of the facts and realities of life. It is not by the exclusive use of the senses or by reading only that the highest development of reason is obtained, but by a proper combination of the two.

And now, gentlemen, a few words to those who are just beginning their professional career. You have probably studied your college calendar and have mystified yourselves to some extent with numberless details of what is about to be required of you. You have grasped the one outstanding and appalling fact that many examinations have to be passed before you can enter the portals of the medical profession. The terrors of these examinations have probably been enhanced by your friends—by those who have failed, because they wish to impress on you an explanation for their failure, and equally by those who have passed, who are anxious that you should realize the value of their achievements. You have very likely been told that for the next five years your life will be made a burden to you by their constant ordeals, and if that were in reality all you had to look forward to your existence would indeed be insupportable. But it is not so; and I implore you to remember from the first, from the very commencement of your professional studies, that the aim and object of those studies is not primarily or to any important degree to enable you to pass certain examinations, but that their object is to teach you your work, and to train you in the duties of your profession. A man who knows his work will certainly pass his examinations; but, on the other hand, many men have passed successfully only to find out afterward that they did not know their work, and that their best opportunities for real study had passed away. The best advice I can give you is to put all thought of examinations out of your minds, to do the work that your teachers direct you to do, and to do it thoroughly, and when the time comes for the final effort, when each man strains every nerve to collect all his knowledge in a concrete form, you will find what a comparatively easy task you have before you, and examinations will lose their terrors. Work for the sake of the work itself, and it will well repay you. Some men work to make a living, some for ambition's sake, and some for the pure love of doing good to their fellow creatures. Now I presume that most of us take up the medical profession with the object of making a living, and a very good object it is, too. I am not going to pretend to you that our one and only stimulus is the opportunity presented to us through our profession of doing good; you all know that it is not so; you have decided to join the ranks of the medical profession in order to make your way in the world. This is your primary object, but to it is added the great pleasure of knowing that inseparably bound up in the practice of that profession is the fact that we are benefiting mankind. What a stimulus should this be to us to make our work as perfect as we can, not only during our student days, but through the whole of our career.

[Continued from SUPPLEMENT, No. 1067, page 17049.]

## THE MAKING OF A GREAT UNIVERSITY FOR LONDON.

By SILVANUS P. THOMPSON, B.A., D.Sc., F.R.S., in the Journal of the Society of Arts.

### NUMBER OF STUDENTS IN ATTENDANCE.

IT is difficult, in some cases, to state precisely the number of students at a university, owing to the returns not making a distinction between students pursuing a regular course and casual students taking single sets of lectures. It will be noted that Paris and Berlin head the list with 11,000 and 8,600 students respectively. Vienna comes next with 6,700; Naples has 5,000; then come Harvard, Oxford, Cambridge, and Munich, with about 3,700 each; while Edinburgh, Leipzig, Buda-Pesth, and Prague, and St. Petersburg follow with about 3,000. There is a like number in the "Victoria" University, spread over the three colleges in Manchester, Liverpool, and Leeds. Yale University has 2,350; Glasgow, 2,080; Rome has just 2,000; Bonn, Cornell, Padua, and Halle have about 1,700. Graz, Heidelberg, Upsala, Freiburg, Wurtzburg, Tokio, Coimbra and Breslau continue the list to about 1,400. Tubingen, Brussels, Erlangen, Dublin, Genoa, and Strassburg bring the numbers down from 1,300 to 1,000. Below 1,000 though certainly entitled to be called great, come Baltimore, Leyden, Aberdeen, Konigsberg, and Gottingen.

The lowest German university being Rostock, with 420; the lowest British—Durham and St. Andrew's—with 400 and 200 respectively. (I omit the University of Wales as too new to consider and the University of Lampeter as too insignificant to be of account.) The larger of the provincial "Faculties" of France—Lyon and Bordeaux—have about 2,000 students each, and therefore rank with Yale, Glasgow, Cornell, and Halle. Toulouse (formerly a university in its own right) has 1,560; Lille has 1,450; Nancy, 1,000; Grenoble and Dijon about 100 each.

### PROFESSORIATE.

In comparing statistics, it must be borne in mind that in some universities many of the readers and lecturers who do not bear the title of professor, are really doing professorial work. Paris, Berlin, Vienna, and Harvard head the list with 300, 179, 159 and 149 respectively. Then come Leipzig, Tokio, Upsala, Heidelberg, Edinburgh, Cambridge, Oxford, Graz, Cornell, Bologna, Tubingen, Konigsberg, and Greifswald, with numbers running down from 134 to 64. The American universities mostly agree with the German and Italian in having large numbers of assistant professors and privat-docents, the latter being lecturers without stipend, who have the privilege of using the university lecture room when available, receiving fees from such students as voluntarily attend their courses. The number of professors relatively to the number of students varies greatly. In the universities of Oxford, Cambridge, Paris, Vienna, Berlin, Edinburgh and Dublin there is one professor to every 30 or 40 students; while in those of Upsala, Tokio, Strassburg, Konigsberg, Giessen, and Rostock, the proportion is one professor to 10 or 12 students. If privat-docents are included, the figures come out more favorably for the larger universities. At Berlin there are 4·1 teachers (professors and privat-docents) for every 100 students (or 1 to 25); at Vienna, 5·2 per 100 students; Leipzig, Padua, Graz, and Tubingen have 7 for every 100 students; Harvard and Cornell, 9; Padua, Greifswald, and Giessen, 10; Tokio, Strassburg, and Rostock, 11; Konigsberg, 13; while the most strongly staffed are Zurich and Baltimore, with 14 teachers per 100 students.

The sums paid to the professors vary greatly; while a few of the leading professors in Edinburgh make £3,000 to £4,000 a year, their assistants are decidedly underpaid. Excepting the divinity professorships at Oxford or Cambridge, all other professorships in English universities and university colleges are much less highly remunerated. The average value of a university professorship in Europe—taking the assistant or extraordinary professorships along with the ordinary—appears to be about £900 per annum. But the higher professorships in the large universities are in general much more than this. For these an average of £800 would be more correct.

The highest total sum paid to the teaching staff is that paid at Paris, amounting to £116,000 per annum. Harvard pays £101,000, Cornell £54,000, Edinburgh £48,000, Leipzig, £46,000, Berlin, £34,000, Leyden, £33,000. Rostock, with only 420 students, pays its professoriate £7,000 a year, while St. Andrew's, with 200 students, pays £10,000 to its teaching staff. London University having no university professoriate pays nothing to any teaching staff.

### PROVISION OF LABORATORIES, MUSEUMS, OBSERVATORIES, AND OTHER INSTITUTES.

The feature which characterizes the modern university is its expenditure upon its special institutions for the study of the sciences. True, it has for centuries been the practice, in the faculty of medicine and surgery, to provide anatomical museums, as well as clinical institutes and dissecting rooms attached to the hospitals. But the growth of scientific laboratories, chemical, physical, pharmacological, botanical, physiological, and mineralogical, is of the present century. No modern university can be great that is not adequately equipped with institutes for the special studies of the several sciences.

In this respect Harvard University heads the list with its expenditure of £88,000 per annum upon its laboratories, museums, observatories and institutes; Berlin comes next with £73,000, Paris spends £34,000, Konigsberg, £25,000, Leipzig, £24,000, Tubingen £23,000 Giessen, £22,000, Cornell, £21,000, Greifswald and Edinburgh both spend £19,000, Strassburg spends £16,000, Heidelberg £13,000; then—fourteenth on the list, though probably lower if some other universities, Munich, Yale, and Columbia (N. Y.) had been included—Oxford with £12,000, followed by Bologna, Cambridge, Graz and Upsala. Even Rostock, with its 420 students, spends £5,500 per annum on its laboratories and collections. The University of London spends £199 per annum on its one laboratory; but no research is ever carried out there, no instruction is ever given there; it is used solely for examination exercises.

### UNIVERSITY LIBRARIES.

What the laboratories, observatories, and scientific institutions are to the modern university, the library, with its manuscripts, books, pamphlets, and maps was to the university of olden time. But in the faculties of arts and of laws, if the library is indispensable in the study of letters and philosophy, it is also needed for the proper and full study of medicine and of the sciences.

The richest university libraries are beyond all doubt those of Oxford and Cambridge, each of which numbers about 500,000 volumes, without counting manuscripts and separate pamphlets, prints, or maps. Harvard has 448,000 volumes and 350,000 pamphlets. Strassburg has no fewer than 700,000 volumes; Leipzig, 500,000; Vienna possesses 455,000; Heidelberg, 400,000, and 175,000 pamphlets. After these come Tubingen, with 320,000; Upsala, with 280,000; Bologna, with 255,000; St. Petersburg and Dublin, with 230,000; Konigsberg, with 220,000; Leyden, with 190,000. Tokio follows with 188,000 and 100,000 duplicates for lending. Edinburgh and Cornell each have 178,000. Greifswald has 148,000; Strassburg, 141,000; Berlin, 140,000. The library of the University of London has only 25,000 volumes.

The sums spent per annum on libraries are no less significant. In the figures which follow the annual sums spent on library staff and on the acquisition of books are lumped together; but it may be taken that in the larger universities just half or a little more of the whole sum is spent on salaries, while in the smaller less is spent on salaries than on acquisition of new works. Harvard leads the way by spending £9,200 per annum on its library; Oxford, £8,500; Cornell, £7,600; Paris, £6,800; Cambridge, £6,040; Strassburg, £5,750; Greifswald, £3,000; Konigsberg, £2,670; Berlin, £2,550; Edinburgh, £2,412; Graz and Vienna, £2,000 each; Glasgow, £1,800; Giessen and Padua, each £1,400; Aberdeen, £840; St. Andrew's, £630. The University of London spends the magnificent sum of £100 per annum.

One other piece of library statistics may be of interest; that it can be given even fragmentarily is due to the indefatigable editors of "Minerva." It relates to the use made of the university libraries, and deals with the numbers of volumes borrowed from the shelves during the year (1894). With one exception, to be named presently, Vienna heads the list of those known, with 317,000 volumes used during the year. Next comes

Harvard with 104 000; Leipzig, 57,000; Graz, 54,000; Upsala, 39,300, and a number of other German universities, down to Giessen, 15,200 (Giessen has 600 students). But besides those mentioned, there are two very surprising cases. At the actual head of the list stands the University of Tokio (with its 188,000 volumes and 100,000 duplicates), where the number of library entries of volumes taken down from the shelves amounts to 427,000 during the year. As its whole number of students and teachers combined is 1,550, this makes an average of 275 entries per person per annum. The number of entries of readers for the year is 68,000, so that on the average every student and teacher in the university has visited the library 43·9 times during the year, and on each visit has, on the average, taken out or borrowed 6·2 books. It may be, however, that the university library is used by other persons. Nearly half the volumes in the Tokio library are in European languages, the rest being in Oriental languages, mainly Chinese and Japanese. The other exceptional case is that of the University of London. Its undergraduates who are proceeding to degrees number about 2,100. Of these, about half live in, or within reach, of London. Its library of 25,000

THE CORONATION OF THE CZAR—CEREMONIES BEFORE THE CHAPEL OF THE IBERIAN MADONNA.

books is not, however, much used by them or by the past graduates, of whom at least 1,000 reside in or near London. During the last year the number of works borrowed from its shelves was 450, the number of individual readers being about 40. My personal experience is that on the few occasions when I have wanted to go into the library to consult any work, admission has been barred by the circumstance that the room was being used for holding one of the examinations!

A university which has no professors, no museums, whose library is practically unused and unusable, in whose single laboratory no researches are ever made, which is doing no teaching, whose sole possessions are programmes for examinations, candidates to be examined, examiners to examine the candidates, and a building where the examinations are held, cannot be called a great university. Indeed, were it not for the arbitrary definition of that term as conferring the right to grant degrees it could not be called a university at all. It is fulfilling precisely the same sort of function as the Civil Service Commission fulfills. That body, like the University of London, is a state-created body. It has its candidates, its programmes, its examiners, its stringent rules for conducting examinations, its building for holding them. Its examinations are impartially open to candidates from all parts; and as a matter of fact the value of the appointments depending on them is vastly greater than that of any depending on the examinations of the University of London. The Civil Service Commission regulates, among other things, the official methods of spelling the English language. This highly influential body is denied the privilege of conferring degrees upon its most qualified candidates. Yet in the abstract it is just as completely and truly a university as the University of London.

But if the educational position of the University of London is thus entirely anomalous, still more extraordinary is its financial position. We have seen how large are the sums, whether derived from property, from fees, or from state or municipal grants, which all the great universities enjoy; and how essential such financial support is to their discharge of their functions. With the exception of the three great historic universities of Oxford, Cambridge, and Dublin, and the more recently created American universities, all universities, great or small, are in receipt of state aid, some almost entirely dependent upon it. Government, in one form or another, gives £29,000 a year to Edinburgh, £24,000 a year to Glasgow. To the University of Wales and its colleges the state grant is £15,000 a year. To the provincial university colleges of England it gives £15,000. To the Royal University of Ireland and the three Queen's colleges the total grant is £44,000.

On the Parliamentary Estimates the University of London also appears, nominally, as the recipient of £16,050. But what the state gives with one hand it more than takes away with the other, for it rakes into the treasury the fees paid by candidates for examination by the university, and these amount to £17,152. So the University of London, instead of receiving state support, actually supports the state by the amount of £1,102 per annum. In addition to this the Treasury charges the university—a state institution, be it remembered—with a sum of £1,901 for repairs, furniture, fuel, gas, and rates, in respect of its building, and £70 additional for auditing its accounts at the government audit office. These sums the university has to pay out of its slender income from provincial and school examinations. So that it actually pays to government a subsidy of £3,073. These facts are not generally known. But what a commentary they furnish upon the appreciation of higher education in England! Scotland, with a population of 4,000,000 persons, is given £70,000 a year to maintain its four universities; Wales, with 1,800,000, is given £15,000; Ireland, with 4,700,000 people, receives £44,000, and has an endowed university in Dublin besides. While London, with its 5,000,000 inhabitants, not only has no teaching university at all, but has as a university a mere examining board, whose profits of £3,073 a year are seized by government, while the sum of £1,700 a year is paid to University College, and £700 to Bedford College (women), out of the £15,000 a year allotted to English university colleges. King's College is also to have a small grant during the current year. The total sum paid to the above two London colleges amounts to £2,400 a year. Well may we say that this is a London question. How is it that every member of Parliament sitting for a London constituency does not demand that justice shall be done at home? London members will cheerfully vote thousands of pounds for university maintenance elsewhere, while their own university is not only crippled and tied down to perform the lowest only of all university functions, but is taxed by the state for the privilege of doing even this.

### THE PROBLEM FOR LONDON.

The problem therefore presents itself—How is London to be provided with a great university? It is not a problem of which the solution has never been attempted elsewhere. On the contrary, some of the great universities are of quite recent origin. The great University of Berlin was founded in 1810. About the same time was founded the University of Bonn, made famous by association with the names of Clausius, of Von Hofmann and of the lamented Heinrich Hertz. Since the date when the existing charter of the University of London was granted—1863—several great universities have been founded, either by enlarging older and smaller bodies or by creating new ones. Since that date, the universities of Cornell, Tokio, Baltimore and Chicago have been created. The University of Strassburg has been founded upon the nucleus of the old faculties previously existent. The University of Paris has been reconstructed, and its old Sorbonne replaced by a new Sorbonne, around which a magnificent series of institutes, museums, and laboratories have grown up. All over France the provincial faculties, which under Napoleon had been pinched to exalt the glories of the central University of Paris, have, since the great disasters of 1871, been reorganized on a liberal scale, and are now practically local universities. In England, the "Victoria" University has been organized as a federal university upon the basis of the three flourishing colleges at Manchester, Liverpool and Leeds. Of all these new developments, perhaps the most striking is the case of Strassburg; since it shows what can be done when a clearly defined purpose of creating a great university is carried out with knowledge and energy, and with the resources of a nation to insure success. A series of "institutes" or laboratories was built for the various departments of science, at a cost of from £16,000 to £35,000 apiece, and annual sums for maintenance allotted to them, varying from £300 to £1,300 each. The total sum spent on reconstructing and equipping the university was £711,000. The imperial government gives a subvention of £46,000 a year. Within the year this splendid array of institutes has been enlarged by the addition of two new buildings. A new clinical hospital has been added at a cost of £22,500 and a new zoological laboratory museum at a cost of £17,300; this latter being a gift of the municipality. £5,750 a year is spent on the library—now the largest of any university on the Continent—£1,600 a year on the maintenance of the museums, laboratories and medical schools, and £26,000 on the salary of the professoriate staff. The chairs are regarded in Germany as ranking with those of Munich and Leipzig, being next in value to those in Berlin. The university can therefore secure the most eminent men as professors, and so be certain of attracting the best class of students, raising the standard both of learning and teaching, and insuring the best possible guarantee of the permanence and reputation of the university. Thus did Germany raise an intellectual fortress to guard her frontier.

## ON THE ROENTGEN RAYS ELECTRIZED.

By A. LAFAY.

THE experiments on Roentgen's rays electrized which I have already had the honor of communicating to the Academy give room for an objection which it was necessary to remove. We may ask ourselves if these rays really undergo a change of nature, an electrization, in traversing the electrized lamella, or if the deviations observed are merely the result of the combined effect of the electromagnet and of the electric field developed by the silver plate.

To remove this uncertainty, I have repeated the experiments already described, and I have caused the electrized ray, on its issue from the lamella, and before its passage between the keepers of the electro, to penetrate into a Faraday case placed in communication with the earth. The sensitive plate was contained in the interior of the metallic case, which presented merely a small aperture destined for the entrance of the rays. In these conditions, which eliminate as far as possible the effects of the electric field, I have observed the same deviations as formerly.

In order to throw yet more light on the nature of the electrized rays, I have repeated with them the experiment which M. Perrin has performed on the cathodic rays.

In the present case, the execution of the experiment presented no difficulty. For the ball of a gold leaf electroscope I substituted a Faraday's cylinder, the aperture of which is turned upward. The apparatus, thus transformed, is completely inclosed in a metallic cylinder, the upper opening of which is closed with a leaden cover which has a central aperture. Above this aperture I arrange a silver plate connected to a Wimshurst machine, which serves to electrize the rays sent by the Crookes tube, placed above.

In these conditions, I observe that the Faraday cylinder is charged with electricity of the same kind as

that supplied to the electrizing plate. The phenomenon continues if we substitute for silver a metal leaf of any kind sufficiently thin to be traversed by the Roentgen rays.

We still obtain the charge of the cylinder if we close the aperture in the leaden cover with a transparent dielectric (paraffin, ebonite, paper, etc.); it is no longer the same with an opaque dielectric, such as a plate of glass with a base of lead.

In view of this result, it is natural to demand if a very thin sheet of metal placed in communication with the earth would not equally allow itself to be traversed by the electrized flux, and if the conductivity of the metal would be sufficient to deprive the rays of all their electricity.

It has not yet been possible for me to satisfy myself of this fact by an experiment such as I have just described, but we must remark in the present case the radiation is weakened by its passage through the plate; and that, further, the Roentgen flux, acting as a conductor between this plate and the Faraday cylinder, increases the losses of the electroscope. This is why I purpose, by a method slightly modified, entering upon the investigation of this question, which presents a great interest, and would give the key to the remarkable results obtained by Lenard.

I shall conclude this paper by indicating a very curious fact. In my former communication I had, after the example of Hittorf, assimilated the Roentgen flux to a sheaf of flexible conductive wires. This manner of conceiving the phenomenon occasioned me to modify the experiment already described in the following manner:

I completely inclosed the photographic plate with leaves of aluminum, then putting the platinum wire and the lead screens in communication with the earth, I have, while the electromagnet was at work, electrized the metallic envelope containing the plate.

In these conditions, the hypothetical filaments of Hittorf permit the efflux of the electricity developed on the aluminum, and should, in consequence, bend in a direction determined by the action of the magnetic field.

The deviations observed have entirely confirmed this view, and I have thus verified—a result at first slightly paradoxical—that it is indifferent for deflecting the Roentgen rays to electrize them before and after their passage across the magnetic field.—Comptes Rendus.

## NOTES ON STEAM SUPERHEATING.*

By Mr. WILLIAM H. PATCHELL, of London.

NATURE of Steam Superheating.—Superheated steam is steam of any pressure at a temperature higher than the temperature of its evaporation from water at that pressure. Saturated steam may be superheated by imparting additional heat to it at constant pressure, during which process its volume increases. By permitting saturated steam of a given pressure to expand without doing work, superheated steam at a lower pressure may be formed. Steam cannot be superheated in the presence of the water from which it was evaporated, owing to the fact that the water takes up the heat and evaporates into further saturated steam. The corollary follows that water cannot exist in the presence of superheated steam; either the surplus heat in the steam will evaporate the water or, if there be too little surplus heat to evaporate all the water, the steam will immediately become saturated by evaporating as much of the water as it can.

Messrs. Fairbairn and Tate, Hirn and Siemens, all found that saturated steam was not a true gas, and that its expansion on the application of further heat was at first much greater than that of a perfect gas. When a temperature of about 20° Fah. above that of the saturated steam was reached, the volume increased at about the same rate as that of a perfect gas. No data appeared to be yet available as to the expansion of steam with high degrees of superheat; but there is little doubt that it would be that of a perfect gas. A marked feature in the use of superheated steam is the rapid fall in the superheat from radiation, etc. The reason of this more rapid fall in temperature as compared with saturated steam seems to be that the latter owes its heat-retaining properties to the water spray carried in it. It is only after this water spray has been evaporated that the steam becomes a true gas.

Aim of Superheating.—The greatest advantage to be gained by the use of superheated steam is in engine cylinders, and is due to the immediate absorption of the film of water on the metal surfaces by the surplus heat, thereby counteracting cylinder condensation, which is the heaviest loss in the expansive working of steam. In this connection superheated steam would appear to have an advantage over steam jackets, inasmuch as the heat is applied exactly where it is wanted and during the period that it is wanted, that is, up to the point of cutoff, whereas a steam jacket wastes a considerable part of its heat and time in warming up the exhaust.

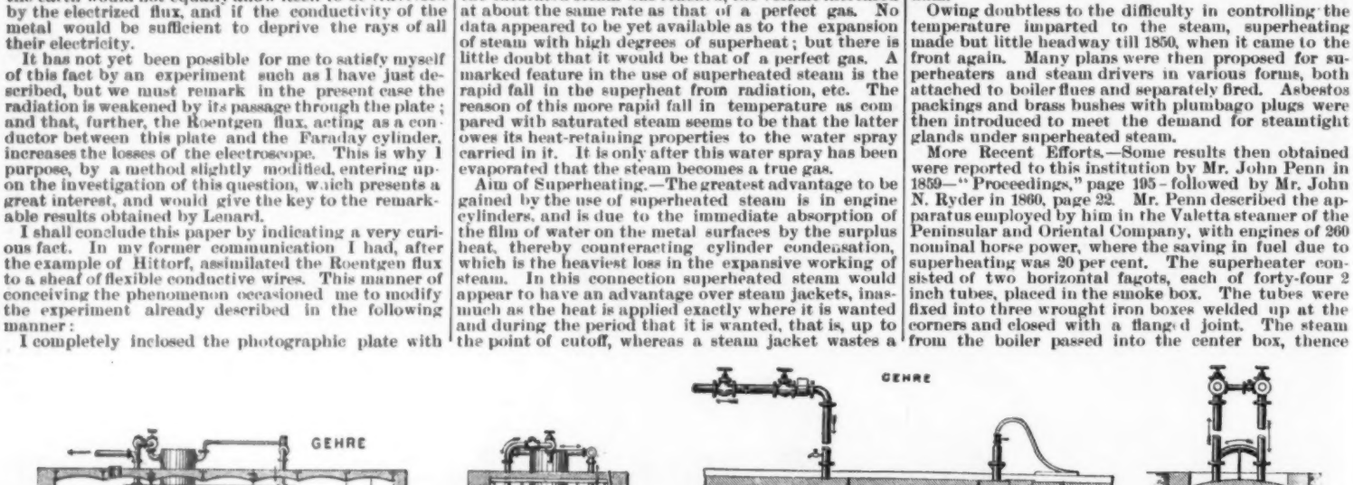
Early Attempts at Superheating.—That economy attends the use of superheated steam in engine cylinders has been known at least since 1828, when Richard Trevithick reported on the engines at Binner Downs mine in Cornwall.* The engineer of the mine, Capt. Gregor, wishing to rival the record of a neighboring mine, where the cylinders had been incased in sawdust, built in his cylinders and steam pipes with brick work, making a fire grate underneath them and flues around. The results were unexpected, and the duty of the engine was raised from 41,000,000 to 63,000,000 foot pounds per bushel (84 pounds) of coal. Trevithick tested the 70 inch cylinder engine, which, when 5 bushels of coal were burned in 24 hours under the cylinder, took 67 bushels under the boiler. When no coal was burned under the cylinder, 108 bushels of coal were used under the boiler for the same work, showing a saving of one-third of the coal by superheating. The steam pressure was 45 pounds per square inch and the strokes 8 per minute. With the cylinder fires on, 13 gallons of injection condensing water was used per stroke, and heated from 70 to 104 degrees; without the cylinder fires, 15½ gallons of condensing water were used per stroke, and heated from 70 to 113 degrees. Trevithick followed this up by inventing in 1832 a tubular boiler, combined with a superheater between the boiler and the engine cylinder; he also jacketed the cylinder with the waste gases from the furnace.

In Fig. 1 is shown the arrangement, copied from his patent, No. 6,308, of 1832. The external series of vertical pipes, connected top and bottom to a hollow ring, constitute the boiler; the superheating pipes inside it are formed like inverted siphons, so as to avoid jointing at the lower end next the fire. Trevithick had been combating cylinder condensation for thirty years before this date, having in 1802, in conjunction with Vivian, constructed a non-condensing engine, the cylinder of which was placed inside the boiler—a plan followed for many years with much success in agricultural portable engines by Messrs. Hornsby, of Grantham.

Owing doubtless to the difficulty in controlling the temperature imparted to the steam, superheating made but little headway till 1850, when it came to the front again. Many plans were then proposed for superheaters and steam drivers in various forms, both attached to boiler flues and separately fired. Asbestos packings and brass bushes with plumbago plugs were then introduced to meet the demand for steamtight glands under superheated steam.

More Recent Efforts.—Some results then obtained were reported to this institution by Mr. John Penn in 1859—"Proceedings," page 195—followed by Mr. John N. Ryder in 1860, page 22. Mr. Penn described the apparatus employed by him in the Valetta steamer of the Peninsular and Oriental Company, with engines of 260 nominal horse power, where the saving in fuel due to superheating was 20 per cent. The superheater consisted of two horizontal fagots, each of forty-four 2 inch tubes, placed in the smoke box. The tubes were fixed into three wrought iron boxes welded up at the corners and closed with a flanged joint. The steam from the boiler passed into the center box, thence through the tubes into the end boxes on its way to the engines, taking up heat from the escaping gases which would have been otherwise wasted. The proportions of the apparatus are given by Mr. Penn as 2¾ square feet of superheating surface per nominal horse power; the boilers had a heating surface of 19 square feet per nominal horse power. The steam pressure was 20 pounds per square inch and the amount of superheat about 100° Fah. Mr. John N. Ryder dealt with Messrs. Parson and Pilgrim's apparatus as fitted on marine boilers, and also Mr. David Patridge's superheater. The Parson and Pilgrim apparatus consisted of two horseshoe pipes fixed over the fire grate in the internal flue of the boiler. Tests on the steamers Osprey and Swift showed a saving over saturated steam of 30 to 40 per cent. in fuel, and on H. M. steam tug Bustler a mean of 37 trials with a pressure of 8½ pounds and a temperature of 380° in the cylinders, which is 144° of superheat, gave 25 per cent. economy. Mr. Patridge's apparatus was a cylinder filled with tubes placed vertically in the uptake. The gases passed through the tubes and the steam around them; the working temperature was from 360° to 390°. H. M. steamship Dee was fitted and tested for several months by the Admiralty, when an economy of fuel from 20 to 25 per cent. was obtained. An aggregate of about 5,000 horse power was stated to be then working with this apparatus.

Following closely on Mr. Ryder's paper was one read by the Hon. John Wethered, of the United States, at the Institution of Civil Engineers—"Proceedings," 1860, vol. xix, page 462—wherein he animadverted on the futility of the common kinds of superheater, and strongly advised mixed or combined steam, which he




FIGS. 1 AND 2.—TREVITHICK AND GEHRE.

FIG. 3

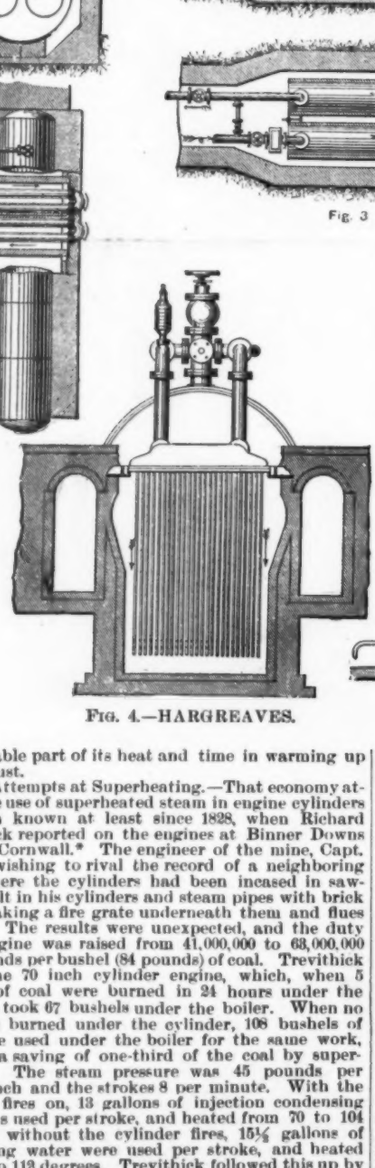


FIG. 4.—HARGREAVES.

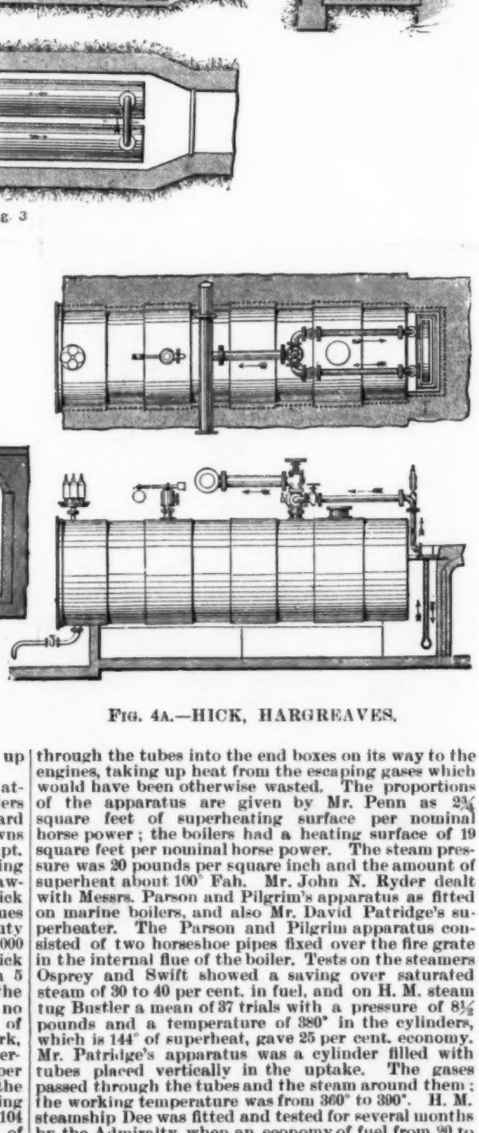


FIG. 4A.—HICK, HARGREAVES.

* Paper read before the Institution of Mechanical Engineers, January 31, 1896.—From the London Engineer.

* "Life of Richard Trevithick," vol. 2, pages 315 and 333-4.

claimed to have introduced from America four years previously.

Reasons for Former Abandonment.—If superheating was so common and of such manifest importance and efficiency in the saving of fuel some forty years ago, the question arises, Why was it given up? and What factors that led to its abandonment have been eliminated in modern practice? Trouble was formerly experienced at the valve faces and in the cylinders from the decomposition and destruction, at the high temperatures of superheated steam, of the tallow and the low class lubricants then in vogue. This trouble was twofold; the cutting and excessive wear in the absence of lubrication, and the pitting caused by the fatty acids in the lubricant. On this score, however, no trouble need now be anticipated, at any degree of superheat likely to be attained, where good hydrocarbon oils are used. Gas engines run in regular working with a cylinder temperature in the neighborhood of 2,000° F., lubricated with good oil; and with ordinary care and attention instances of cutting are not frequent. The common use of metallic packings for glands, and of piston valves in place of flat valves, has removed another serious obstacle. In this connection it will be well to note that pistons and valves which show little leakage when used with saturated steam may show considerable leakage with dry steam, probably owing to the film of water on the metal improving the fit when saturated steam is used.

Much of the trouble that has been attributed to the effects of superheat, in respect of cut cylinders and valve faces, has, in the author's opinion, been due in reality to the effect of alternate superheat and water in the steam, owing to want of proper control of the superheaters. A superheater may give a high degree of superheat when the fires are in good order, and at another time may even act as a condenser. The effect of this alternation demands much closer attention than it has at present received. A somewhat parallel case is the behavior of a good hydrocarbon cylinder oil, which in one engine with normal dry steam leaves no deposit; whereas in a sister engine, at the same steam pressure, with wet steam a heavy deposit is formed from the same oil. An instance of a cut cylinder which had to be rebored has lately come under the author's notice, where it appears from the evidence that the trouble is not to be attributed either to the degree of superheat in itself, or to the lubricant, or to neglect on the part of the engineer in charge, but to the alternate effects of superheated and wet steam in the cylinder.

The majority of the old troubles were met with in the engines; but the superheaters themselves do not appear to have been always above reproach. When endeavoring to trace failures to faults in pipes or joints, the author has sometimes found superheaters which were fixed with a bypass for the steam, but none for the gases. The boilers were then worked occasionally with the steam shut off from the superheater; and it is not surprising that the latter deteriorated rapidly, its position being eminently unsuitable for a combination of boxes, pipes and expanded tube joints.

Reintroduction of Superheating Apparatus.—Concurrently with the increased efficiencies gained in late years in both boilers and engines, competition has also increased; and with it has arisen the continual cry for cheaper power, cheaper transport, cheaper means of production. The result is that engineers cannot afford to dismiss without careful examination the claims of any plan the adoption of which may diminish their consumption of fuel. It is this fact which has again brought superheating to the front, and has made it the subject of close inquiry in many quarters. Several kinds of superheater are now in more or less extensive use; but only one of them is a radical departure from those of forty years ago. Any change in the others is rather in manufacture than in design; and their 'parentage can be traced by their strong family likeness.

Gehre's Superheater.—This is in extensive use on the Continent and has been introduced into this country by Messrs. B. Donkin & Company, of Bermondsey. It is shown in Figs. 2 and 3, and may be either fitted in the boiler flue or separately fired. Some of these superheaters have been fixed in England, but, unfortunately, they have not been tested. Mr. Bryan Donkin kindly gave the anthor a copy of a test made in Germany, of eight hours' duration, on a water tube boiler with and without the superheater, Table I. The heating surface of the boiler was 861 square feet, and of the 'superheater 646 square feet. The superheater was placed directly behind the boiler in a special flue.

TABLE I.—*Boiler Test with and without Gehre's Superheater.*

| | With. | Without. |
|---|---|---|
| Total coal used during trial, lb. | 1,740 | 1,940 |
| Total water used during trial, lb. | 17,400 | 18,100 |
| Temperature of feed-water, deg. Fah. | 205 | 201 |
| Superheat in steam, deg. Fah. | 40 | — |
| Temperature of furnace gases before superheater, deg. Fah. | 600 | 600 |
| Temperature of furnace gases after superheater, deg. Fah. | 510 | — |
| Water evaporated per lb. of coal, lb. | 9·99 | 7·82 |
| Water evaporated per sq. ft. of heating surface per hour, lb. | 2·23 | 2·20 |
| Pressure of steam per sq. in. above atmosphere, lb. | 110-114 | 110-114 |
| More steam used, per cent. | — | 5 |
| Less coal used, per cent. | 34 | — |
| Less work on engine, per cent. | — | 7 |

Hick, Hargreaves & Company's Superheater.—By the courtesy of the makers, the author has been favored with the following particulars and tests, Table II, of their superheating apparatus in a mill at Bolton. As shown in Fig. 4, the apparatus consists of a nest of U tubes, bent to a large radius at the bottom, which are placed at the back of a Lancashire boiler where the hottest gases from the flues impinge upon them. The tubes are suspended from a tube plate, forming the bottom of a box, in which they are fixed by being expanded in the usual manner. The box is divided down the middle by a vertical diaphragm, so that the saturated steam entering at one side passes down and up through the tubes and leaves superheated at the other side. A bypass valve is arranged to regulate the flow of steam through the superheater, because only a portion of the steam from the boiler is intended to be superheated. Main valves are also provided, so that the superheater can be disconnected for examination, or even taken out entirely, without interrupting the working of the boiler. The Lancashire boiler to which the superheater is applied is 8½ ft. diameter and 30 ft. long, with two flues of 3¼ ft. diameter, having nine circulating tubes in each. The grate surface is 39 square feet; the heating surface in the boiler is 1,195 square feet, and in the superheater 120 square feet. The area of passage through the superheating pipes is 22 square inches. The boiler pressure is 100 lb. per square inch above atmosphere. In the tests a portion only of the steam was superheated. The steam pipes to and from the superheater are 3½ in. diameter, and are provided with valves, which were kept full open. The main stop valve on the boiler is 8 in. diameter, and was kept only $\frac{5}{8}$ in. open. The steam was taken to the superheater from underneath this valve, and the return pipe from the superheater was conducted direct to the main range of steam pipe supplying the engine. The temperature of the gases was not taken. The engine is a horizontal tandem compound, fitted with Corliss valve gear; cylinders, 18$\frac{1}{16}$ in. and 36$\frac{1}{16}$ in. diameter by 4 ft. stroke. Each of the tests was of 7½ hours' duration. The much easier working of the boiler for the same indicated horse power at the engine is to be noted. During the tests of March 20 and 21 and March 26 and 27, the load was practically identical. In the former tests with superheating the rate of coal consumption was 18·8 lb. per square foot of grate per hour, whereas in the latter tests, without superheating, the combustion went up to 23·4 lb. of coal per square foot of grate per hour. Where there is a low and uncertain chimney draught, this slower combustion alone would tend to much steadier and more economical steaming, and would more than counterbalance any obstruction in the flues caused by the superheating pipes, which appear to be more imaginary than real.

TABLE II.—*Boiler Tests with and without Hick, Hargreaves, and Co.'s Superheater.*

| Dates of tests. | Number of tests with or without superheater. | Mean load. | Water evaporated per hour. | Coal burnt per hour. | Water evaporated per lb. of coal. | Water evaporated per I.H.P. per hour. | Coal burnt per I.H.P. per hour. | Degrees of superheat. |
|---|---|---|---|---|---|---|---|---|
| 1895. | | I.H.P | lb. | lb. | lb. | lb. | lb. | Fah. |
| February 19—20 | 2 without | 303·55 | 5379·3 | 837·6 | 6·42 | 17·7 | 2·75 | — |
| March 1—2 „ | 2 with | 290·5 | 4706·2 | 667·2 | 7·06 | 16·2 | 2·29 | 42° |
| „ 5-6-7-8 „ | 4 with | 296·06 | 4778·5 | 676·5 | 7·06 | 16·0 | 2·28 | 42° |
| „ 20-21 .. | 2 with | 311·2 | 5141·1 | 734·7 | 7·00 | 15·5 | 2·35 | 55° |
| „ 26-27 .. | 2 without | 311·8 | 5492·1 | 914·0 | 6·00 | 17·6 | 2·92 | — |
| Means ... | without | 307·67 | 5435·7 | 875·8 | 6·21 | 17·6 | 2·84 | — |
| | with | 299·45 | 4848·6 | 688·7 | 7·09 | 15·9 | 2·30 | 45·2° |

Economy in water per I. H. P. per hour 9·6 per cent. with superheating.
Economy in coal per I. H. P. per hour 19 per cent. with superheating.

(To be continued.)

## LATHE FOR TURNING SEVERAL OBJECTS OF THE SAME SHAPE.

THE shaping of a series of objects identical with each other, upon a lathe, is done in an economical and rapid manner with a new machine tool constructed by Messrs. Wagner & Andreas, of Leipzig. This machine, in fact, permits of working upon three pieces at once without detriment to precision or to the rapidity of the maneuvers.

As shown in the accompanying engraving, the head stock of this lathe, although actuated by a single cone pulley, includes three spindles each provided with a center and arranged obliquely upon their common support. In the tail stock there are three other centers that are parallel and arranged one above the other. These rest upon a single support which is capable of assuming various obliquities upon a plate that may be rendered immovable at different points of the bed piece of the lathe, according to the space to be reserved between the centers in order to receive the objects to be turned. It is thus possible to turn conical as well as cylindrical parts.

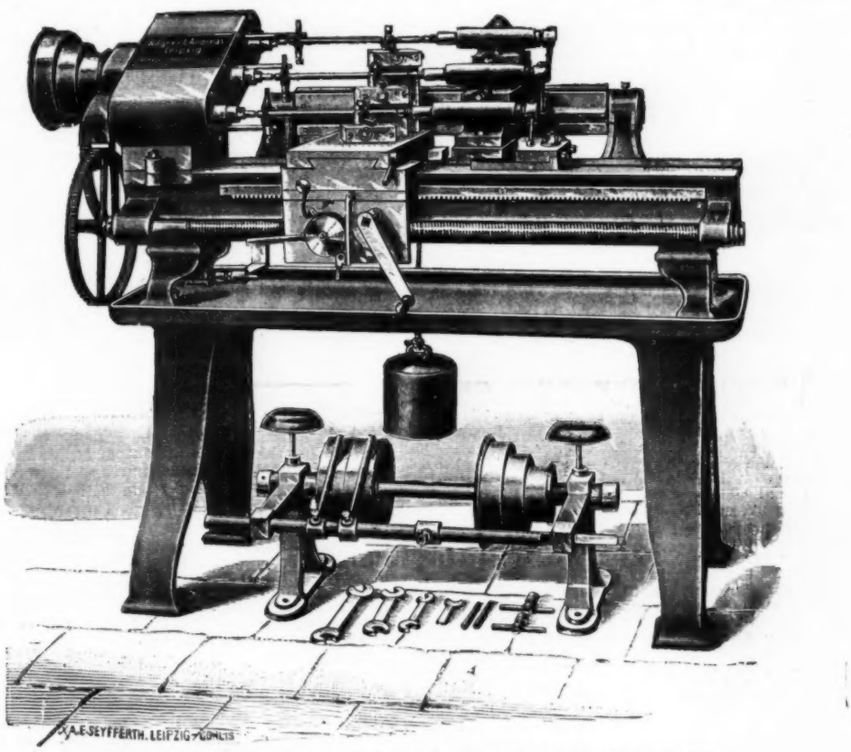
The transverse carriage of the tool carrier is supported, as usual, by a slide arranged upon the bed. It is provided with three steps upon each of which there is placed a tool at a height corresponding to that of the object to be shaped.

The tool carriers can be very quickly brought into a working position by means of a rack whose pinion is maneuvered by means of a winch.

The tools attack the metal at an angle of 65 degrees. Their longitudinal motion is obtained by means of a tempered steel threaded rod that gears with a nut in two pieces, forming jaws that may be opened at will. The forward motion is regulated by the screw at the rate of 0·16 mm. per revolution.

As for the simultaneous displacement of the tools in a transverse direction, that is effected by means of a pattern that reproduces the form that the objects are to have, and which is placed behind the lathe. In order to keep the carriage in permanent contact with this pattern, there is suspended from the first a 30 or 35 kilog. weight carried by a wire wound around a guide pulley fixed to the carriage.

It is possible to pass from one pattern to another with rapidity. To this effect, the patterns are fixed upon a support journaled in two bearings contiguous to the bed. This support exhibits in section the form of a cross or star whose branches carry different patterns. A partial revolution of this support and then its stoppage by pins inserted in holes bored in the journals suffice to produce a new profile in the three objects.




LATHE FOR TURNING SEVERAL OBJECTS OF THE SAME SHAPE.

It is indispensable that it shall be possible to interrupt the contact of the pattern and carriage. This result is obtained by the simple maneuver of an eccentric actuated by the small lever seen to the right of the carriage, and so arranged as to carry it sufficiently toward the front to cause the stoppage of the work.

Besides, an arrangement that automatically limits the longitudinal travel of the carriage is combined with the lever that controls the opening and closing of the nut of the actuating screw through a simple revolution of 45 degrees. This lever forms the rod of a disk carrying upon its periphery a projection that bends a spring when, in order to close the nut of the screw, the hand lever is lowered and its disk is made to revolve.

As soon as this closing is effected, a lever with a click enters a notch in the right side of this disk and holds the tool carriage in a position of gearing, so that the work proceeds automatically. Beneath the bed, in a regulatable position, there is a rod provided with a screw whose point, at the end of travel, abuts against the click of the gearing lever and disengages it from the notch in the disk. The latter revolves under the action of its spring and resumes its initial position. This forces the nut to open automatically and brings about the simultaneous stoppage of the tools.

As regards the construction, properly so called, of this machine, it is not without interest to remark that by reason of the fixedness given to the centers of the head stock, the spindles are not submitted to any wear in their bearings, and consequently preserve an absolute concordance with the back centers. This point is of great importance in the shaping of cylindrical pieces. Besides, the suppression of the work

of friction leads to a smaller expenditure of energy. This lathe is 1·25 meters in length and is capable of turning objects as large as 20 mm. in diameter and 600 mm. in length. It would be superfluous to dwell at length upon the advantages that the use of it presents, so appreciable are they to practical men. Nevertheless, we may call attention to the facility with which the operator can watch the work, this, conjointly with the automatic throwing of the tools out of gear at the end of the travel, permitting him, if need be, to run several machines of this kind at once. It is thus possible, in the shaping of objects in series, to attain great rapidity of production and consequently to effect considerable saving in the net cost.—Revue Industrielle.

## ENGRAVED HALF TONES.*

By M. LAMONT BROWN.

THERE has been, until recently, a law among process workers, unwritten it is true, but quite universal, that whatever supplementary treatment was given to half tone blocks by tooling should conform to the grain made by the screen. Such work has heretofore been limited to removing the black spots made by holes in the film; softening the edges of a vignette by entering the lines with a graver, or to rouletting the darker tones when they need working up. The nearest approach to the technique of the wood engraver has consisted in running through with the graver the lines made by the screen, taking out every alternate line. When used in conjunction with skillful re-etching, these methods answer the requirements in some cases, and will doubtless continue to be considered adequate by many process workers.

It would be, perhaps, an unwarranted assumption to say that the half tone had now reached its highest point of mechanical perfection, and that nothing further can be looked for in that direction. Mr. Levy is still experimenting with the screen, and his latest developments are not without promise. One thing seems quite sure, however, and that is, that the screen will continue to be used, whether ruled in a regular or an irregular series of lines. And it will still continue to be the fact that a picture which is manufactured by purely mechanical means, however perfect, will fail to satisfy an existing demand for more artistic methods of reproduction.

The last year has witnessed an important departure from the use of mechanical methods in perfecting half tones. It is in effect a partial return to an older style of work, being the application of the wood engraver's technique to the copper half tone block. Without attempting an elaborate exposition, it may not be out of place to set forth briefly some of the reasons which especially adapt white line engraving to the supplementary treatment of half tones. Assuming then that photo engravers know less about wood engraving than is probably the case, it will be observed on examination that the portions of a wood engraving which stand out in relief on the block, be they lines or dots, are generally coarser than the half tone grain, and that the white interstices which do not offer any surface to the roller are also much larger. This difference, as such, may not be apparent to the untrained eye, especially in the better class of wood engraving appearing in magazine work. The general public has, however, learned to distinguish a half tone by its pervading softness of color, which is generally held to be one of its chief beauties. On the other hand, the bold, free lines of wood engraving, although in keeping with the letterpress of the printed page, are less pleasing to the average eye. There is a variety and diversity of surface and texture characteristic of a good woodcut that baffles the eye, and though the handling be comparatively coarse, its lack of sameness makes it less apparent than would be the grain made by an equally coarse half tone screen. Judged from an artistic point of view, the fineness of grain and sameness of texture which characterize the half tone are not altogether desirable qualities. Compare a mezzotint with a line engraving, and it will be seen that the color of the former is opaque. The half tone resembles a mezzotint in this, for the sky tints and distances are apt to lack transparency. But a still more serious defect in the half tone, from an artistic standpoint, is the lowering or darkening of the light tones, which results in a dull and spiritless picture lacking in contrast. The method of restoring the qualities which are thus lost by the interposition of the screen must accomplish the end without injury to the "printable" qualities of the plate, and with the least possible sacrifice to the modeling. Rouletting the lights is a custom that is more honored in the breach than in the observance, and the only other mechanical device consists in re-etching those parts which are still too heavy. This undoubtedly does the work effectually by reducing the surface of the grain presented to the roller, making the dot finer and sharper. But it has the disadvantage of making harsh outlines, and is impracticable in small and broken lights.

Notwithstanding, then, the autographic quality of this method of reproduction, its use in the better class of books and magazines might have been of doubtful duration, had it not occurred to some one to apply wood engraver's technique with a view to making the result more truly interpretative. The half tone gains in transparency and luminous qualities by the introduction of the white line, which lets more light into the color. At the same time the monotony of the grain is broken and one tone is relieved against another by contrasted textures. It will be apparent that this method differs from all the others mentioned in that its successful use demands greater artistic ability and a technical training in the use of the graver. Its immediate success and steady growth in the United States is due to the fact that many good engravers were ready to undertake work of this kind, some of whom to-day frankly prefer it to engraving on the wood. The first important contribution of this style of finish, which may be designated the engraved half tone, appeared in October, 1894, in Harper's Monthly. The Century was not far behind in making use of it, and to-day the half tone pictures, even in the less expensive magazines, such as Munsey's, are nearly all finished by wood engravers. It quite naturally follows, however, that the cheaper magazines employ engraving with less discrimination, and those who have not examined carefully the half tones used by the leading New York publishers will not, perhaps, be very ready to credit the newer method with what is really its due. Some of the cheaper work which has appeared has been very crude and coarse, and is calculated to create a distaste for any kind of hand work that does not conform to the half tone grain. If it were possible at this point to show the first print made from a half tone as it came from the etcher, together with a subsequent impression showing what the engraver had done, it would be much more effective than anything that can be written. To illustrate the spirit which has animated those who have been instrumental in fostering the development of the better kinds of process work, we may instance a case that will show how far removed it is from the commercial spirit which seeks only pecuniary advantage by catering to a supposed fad, and is satisfied with what it calls the "woodcut finish." The finished proof of what would generally be considered a first rate half tone reproduction of one of Mr. Alfred Parsons' charming drawings is submitted for approval to the editor of engraving for one of our leading publications. He finds Mr. Parsons' technique admirably held, the washes crisp and decided, and the general effect such that any one familiar with his work would say at once, "That is from a drawing by Parsons." On a more critical examination, however, the editor finds that the translation has sacrificed some of the essential qualities of the picture. The light fleecy clouds are now of the same general tone that pervades those washes in the drawing which suggest the blue of the sky. The proof shows also that the deeper shadows in the foreground foliage have not been held, and have lost much of their value. In short, the reproduction is found to be less truthful than the first glance might indicate. In order, then, to bring the block up to the key in which the original is pitched, to give it luminosity and strength of contrast, it is placed in the hands of a competent engraver, who proceeds with the finishing of the half tone in much the same manner as with a wood block which has been found unsatisfactory. Where there is too much color he takes out the metal with the graver in a series of lines that need have no reference to the existing grain. If the clouds in the drawing show nothing but white paper in the high lights, he can remove the tone which the interposition of the screen has made on the corresponding parts of the block, taking care to avoid hard edges that might catch the roller in printing. The shadows in the present instance will come quite right after a vigorous burnishing, and the final proof results in a thoroughly artistic and truthful translation of the orignal drawing.

It not unfrequently happens that, owing to some peculiarity in the medium used, especially in reproducing paintings, that which appears as a smooth, quiet shadow in the painting will come mottled and broken in the half tone, notwithstanding the greatest care in the manipulation of the film. In that case there is nothing to do except to burnish the parts until they would print solid black, and then give them the right value with a fine stipple or white line.

Of course it has been taken for granted, in the foregoing brief sketch of the possibilities of the engraved half tone, that a screen no coarser than 175 lines should be used, and that the etching must be on copper by the enamel process.

* From the Process Year Book for 1896.

TEST FOR OLIVE OILS AND SEED OILS.—For the discrimination of olive oils and other oils liable to be used for adulteration, R. Brule applies nitrate of silver in the following manner: 25 parts of silver nitrate are dissolved in 1,000 parts of 95 per cent. alcohol, and 5 c. c. of this solution are added to about 12 c. c. of the oil under examination, which should be filtered if not quite clear, then the test tube is heated in boiling water, and the effect observed.

| KIND OF OIL. | COLOR AFTER HEATING IN BOILING WATER. |
|---|---|
| Virgin olive oil. | Bright green. |
| Olive oil of second and third pressures, containing some olive kernel oil. | Darkens slightly, quickly changing to intense green. |
| Olive oil of inferior quality, strongly colored. | Same as previous oil, but takes longer (15 to 20 minutes). |
| Cottonseed oil, pure. | Black. |
| Earth nut oil. | Brownish red, greenish as it loses in transparency. |
| Sesame oil. | Dark, reddish brown, not changing to green. |
| Rape seed oil. | Greenish yellow, then opaque. |
| Poppy seed oil. | Same as preceding. |

R. Brule states that with practice it is possible to determine in many cases thus colorimetrically 5 to 10 per cent. of one of these oils in a mixture. In the same way natural butter, which gives no change, may be distinguished from artificial butter, the latter, owing to the presence of margarine, acquiring a brick red color, and the proportions in a mixture may be approximately determined.—Comptes Rendus.

THE blasting operations at the Iron Gates, on the Lower Danube, are nearly finished, and it is expected that by next September the obstacles which have hitherto impeded navigation will have been removed. As soon as the channel has been cleared it will be possible for large ships to ascend the river as far as Vienna, and in Austro-Hungarian military circles the erection of suitable fortifications for the protection of the waterway will have to be taken into consideration. Although the rocks at the Iron Gates hindered traffic, they, at the same time, formed a natural barrier for hostile vessels. This barrier having now disappeared, measures will be taken not only to increase the existing flotilla of Danube monitors, but to strengthen it by the addition of a number of torpedo boats. In order to accommodate the latter during the winter months, it is intended to construct a harbor at Buda-Pesth, and with that object in view preliminary arrangements have already been made. It is anticipated that at the next meeting of the Austro-Hungarian delegations this subject will be discussed.

## SELECTED FORMULÆ.

**Window Polishing Paste.—**

| | |
|---|---|
| Castile soap | 2 ounces. |
| Boiling water | 3 " |

Dissolve, and add the following in fine powder:

| | |
|---|---|
| Precipitated chalk | 4 ounces. |
| French chalk | 3 " |
| Tripoli | 2 " |

Mix, and reduce with water to the consistency desired.

**Postage Stamp Mucilage.**—Postage stamp mucilage is made by dissolving one pound of gum dextrin in a pint of boiling water, straining through flannel and adding 2 ounces of acetic acid. When nearly cold add 4 ounces of alcohol, stir constantly and finally enough warm water to make one quart.

**To Detannate Medicinal Wines.** — The following method is used by M. Rozsnyai (Pharm. Post.): Fortify the wine by the addition of about 5 per cent. alcohol, so as to increase the alcohol strength to 18 per cent.; precipitate the albuminoids by the addition of 10 to 15 grammes tannic acid to the hectoliter of wine, allowing to stand five or six days and decanting; remove the added as well as the natural excess of tannin by the addition of gelatin in thin sheets (33 grammes to the hectoliter), which is allowed to remain in the wine from eight to fourteen days. If the gelatin in solution be added to the wine, a certain amount of it remains dissolved, but when added in sheets it merely swells and does not dissolve, at the same time effectually removing the tannin. The finished wine can be used in dispensing alkaloidal and iron salts without causing precipitates or discolorations.

**Effervescent Pastilles.** — Effervescent pastilles of lemon, orange, pineapple, raspberry and vanilla, for refreshing lemonades, are made after the following general formula:

| | | |
|---|---|---|
| (a) Tartaric acid, Sugar, of each | | 50 grammes. |
| Mucilage, sufficient. | | |
| Make pastilles No. 32. | | |
| (b) Sodium bicarbonate | | 70 grammes. |
| Sugar | | 30 " |
| Raspberry ether (or respective ethers for other flavors) | | 25 drops. |
| Cochineal color, Mucilage, of each, sufficient. | | |
| Make pastilles No. 32. | | |

One colored pastille is to be dissolved in one-half tumblerful of water and then one of the white pastilles thrown in. To color use caramel for orange, crocus for pineapple, lemon and vanilla, and cochineal for strawberry and raspberry.

**Laxative Fruit Sirup.—**

| | | |
|---|---|---|
| (1) Figs | | 4 ounces. |
| Sugar | | 12 " |
| Water, a sufficiency. | | |

Bruise the figs in a clean iron mortar, add ½ pint boiling water, and after digesting one hour strain the mixture through a hair sieve or coarse flannel. To the expressed liquid add the sugar and heat the mixture upon a water bath for twelve hours. Finally strain and add enough water, if necessary, to make the sirup measure a pint.

| | | |
|---|---|---|
| (2) Senna leaves | | 2 troy ounces. |
| Buckthorn bark | 128 | grs. |
| Jalap | 384 | " |
| Rhubarb | 256 | " |
| Cinnamon | 30 | " |
| Cloves | 30 | " |
| Nutmeg | 15 | " |
| Oil peppermint | 20 | minims. |
| Sugar | 12 | troy ounces. |
| Diluted alcohol, q. s. for | 16 | fluid ounces. |

Reduce the drugs to a moderately fine (No. 50) powder, add to it the oil of peppermint and percolate it, in the usual manner, with the diluted alcohol. Remove the first 8 fluid ounces of the percolate and dissolve in this the sugar with the aid of gentle heat if necessary, to avoid loss of alcohol by evaporation. Allow the solution to cool, collect the water portion of the percolate and add it to the sirup, so as to make 16 fluid ounces.

| | | |
|---|---|---|
| (3) Senna leaves | 16 | ounces. |
| Coriander seeds | 6 | " |
| Figs | 24 | " |
| Tamarind | 18 | " |
| Cassia pulp | 18 | " |
| Prunes | 12 | " |
| Extract licorice | 1½ | " |
| Essence of peppermint | 1½ | " |
| Sugar | 8 | pounds. |
| Water enough to make | 1 | gallon. |

Make a watery extract to measure 4 pints. Add to this the sugar and enough water to make the whole measure 1 gallon.

**Salad Dressing.—**

| | |
|---|---|
| Mustard | 1 ounce. |
| Acacia (granulated) | 1 " |
| Sirup | 4 fluid ounces. |
| Olive oil | 6 " |
| Vinegar or diluted acetic acid | 8 " |

M. —P. W. Bedford, in Pharm. Record.

**Flash Paper.**—Carefully mix equal parts of nitric acid (1·42 specific gravity) and sulphuric acid (1·84 specific gravity). When the mixture has cooled to 70° Fah., immerse in it white Japanese tissue filtering paper cut into strips one-half inch wide and as long as desired. Cover the vessel with a glass plate and let stand for twelve to sixteen hours. Remove the paper, wash in clear water, and dry as usual for gun cotton. When used roll up a strip into a pellet and light one corner of it, throwing it into the air as you do so.—Nat. Dr.

**Test for Aldehyde in Alcohol.**—To 10 c. c. of the alcohol add 4 c. c. of the following solution:

| | |
|---|---|
| Solution of fuchsin, 1 in 1,000 | 30 c. c. |
| Solution of sodium bisulphite, 34° B. | 20 " |
| Sulphuric acid | 3 " |
| Distilled water | 200 " |

Use soon after mixing. Cannot be used quantitatively. Proposed by M. E. Mohler.—Compt. Rend.

## ENGINEERING NOTES.

**A Russian** railway engineer, V. Herzenstein, estimates that on main lines the life of a creosoted pine sleeper is 15 years, oak 18 years, and beech 20 years.

**At the** present time there are owned and controlled by the railroads and private car companies of America nearly 1,250,000 freight cars, or in other words, enough cars to make two continuous trains reaching from Boston to San Francisco, with an engine for every 45 cars.

**A recent** issue of L'Energie Electrique gives the following mixture for cleaning the parts of machinery, which it states attacks the hardest crust of hardened oil: Boil the parts for three minutes in a solution of 150 parts of sodium carbonate and 15 parts of caustic soda in 1,000 of water, after which rinse and dry the metal.

**Travelers** to Newcastle, England, will have noticed at the north end of the High Level Bridge one of Stephenson's earliest locomotives. It was known as Puffing Billy, and has been deteriorating owing to exposure to the weather. The Northeastern Railway Company has decided to place this relic in the interior of the Central station, just as No. 1 locomotive is preserved on the platform of Darlington station.

**At the** spring meeting of the Iron and Steel Institute, held a few days ago in the hall of the Institute of Civil Engineers, Westminster, the Bessemer gold medal for 1896, which is awarded annually in recognition of meritorious services in advancing the science or practice of the metallurgy of iron and steel, was presented by the chairman to Dr. Hermann Wedding, of Berlin, in acknowledgment of his contributions to metallurgical literature.

**A gun cartridge** exploded in the central powder magazine of the French ironclad Admiral Duperré at Toulon recently, blowing out the magazine door to a distance of thirty feet. The magazine was closely packed with three tons of explosive shells, but no further harm was done. The crew of the vessel stood to quarters and pumped water into the magazine, while Admiral de Cuverville went in to find what had happened, all expecting to be blown up.

**A serious** accident occurred to the new dock at Hull, England, May 15, which involved a loss of over $500,000. The dock was virtually completed and a caisson had been fixed at its entrance to prevent the water coming in. The caisson collapsed at high tide, and the tide water flowing in from the old dock forced the vessels in the new dock adrift. The flow of water was so strong that none of the vessels could be controlled, and their contact with one another injured them greatly.

**After making** a number of experiments on the heat conducting power of iron and steel, says The Engineer, Mr. W. Beglinger arrived at the following conclusions: The results show that the heat conducting power of the different kinds of iron is altogether different. It is, therefore, of the greatest importance to know the coefficient of the inner heat conducting power. Steel and wrought iron show a more uniform conduct in this matter than cast iron. It is not confirmed that hardening reduces the conducting power of steel by almost one-half, though it may be conceded that hardening will reduce it slightly. The difference in working, by forging or rolling, showed only in one case, with wrought iron, considerable differences for the conducting power, steel never. Casting seems to cause far more irregularities. Wrought iron showed generally better conducting power than steel.

**On the** Halberstadt-Blankenburg Railway, in Germany, graphite is reported to be in successful use for lubricating the inner vertical faces of the outer rail heads on curves, says Industries and Iron. It is ground very finely and mixed with just enough water to form a thick paste, and when applied to the rails dries quickly, and the thin layers formed adhere a reasonable time to the rails. During the wet season of the year it appears that there is no necessity for lubricating the rails. Experience shows that in dry weather it is advisable that the line watchman should lubricate the rails every five days, although, doubtless, the frequency of the lubrication will depend upon the amount of traffic. On the Hartz line it is said the trains are hauled by six wheel coupled engines with trailing Bissel truck. Prior to the introduction of graphite lubrication, the tires had to be turned every four or five months. The original tire material, which was too soft, was replaced by Krupp crucible cast steel, and at the same time the lubrication of the outer rails introduced. The tires now need turning only after they have been in service eighteen months to two years. The same lubricant is also used on the sections of the line which are worked on the Abt system for lubricating the rack and spur wheels.

**An experiment** on a large scale is being made with the sewage of Exeter by means of what is called the "Septic Tank System" devised by Mr. F. J. Commin, the Exeter city surveyor, says The Engineer. The plant, which was laid down in January last, and was filled on the 23d of that month, and has been at work ever since, is situated close to the river Exe, near the main sewer from St. Leonard's, a part of the flow from which is dealt with by the system. The quantity handled is ordinarily 7,500 gallons per day, which would represent the sewage of from 300 to 400 people. There is no "treatment" in the ordinary sense of the word. No chemicals or other ingredients are added to the sewage. The "septic tank" is 24 ft. long by 9 ft. 6 in. wide, and from 3 ft. 6 in. to 4 ft. deep, and is arched over and covered with earth. Its capacity is about 6,000 gallons. During the progress of the sewage through this tank, which occupies some twenty hours, it is cut off from light and air. The tank is formed with inlet and outlet, arranged so that the upper portion of the contents are undisturbed. A sewage scum forms on the top, eventually reaching 3 inches in thickness, and by this all soluble solids are thrown into solution by bacteriological action. The outflow from the tank is comparatively clear and odorless, and is considered quite fit for discharge into the sea or tidal water, or for filtration or for utilization on land.

## ELECTRICAL NOTES.

**Work** is well in hand in connection with the construction of the electrical tramways at Cairo, the concession for which is held by a Belgian company.

**The new** telegraphic cable between Germany and England is to start from Borkum, one of the Frisian Islands, and land at Bacton, a village on the coast of Norfolk, between Yarmouth and Cromer.

**The construction** of the Madras electric tramway is making progress, the third section having just been completed and opened for traffic. This section of the line is on the overhead conductor system.

**Work** is rapidly approaching completion on the construction of the electric tramways in Cape Town. The work of erecting the boilers, of which there are three of 300 h. p., of the Heine type, is now in hand.

**Cheap telephone** service is in practical demonstration at Shelbyville, Ind., says the Electrical Review. A mutual company is said to be maintaining an adequate and satisfactory service there with 225 subscribers at $1 a month. This system applies not only to the city, but to the adjacent country as well.

**It is** said that calculations as to the speed of an electric locomotive and train of the weight of the Empire State Express, running at the speed of seventy miles an hour, show that, without increased cost of coal, the electric motors could make a speed of 108 miles per hour, indicating that much higher speeds are economically possible with electric motors.

**A new** portable search light has been put upon the market. It weighs less than fifteen pounds, which permits of its being carried without fatigue, or it can be suspended by a chain and operated by the officer of the watch. With 15 amperes of current at a pressure of 45 volts, small objects, such as spar buoys, three-fourths of a mile distant, can be easily made out, while sails have been seen three miles away.

**The subjects** to be discussed at the International Electrical Congress to be held at Geneva in connection with the Swiss National Exhibition are five in number —namely, magnetic units and their proper names, photometric units, long distance transmission of power and the question of the employment of alternating or continuous currents for that purpose, the protection of high tension lines from atmospheric discharges, and, lastly, the various troubles caused by electric tramways.

**The Brooklyn Heights Railroad Company** has made a contract with an express company for the transportation of baggage throughout the city on a plan similar to that employed on steam railroads, and in a short time regular express cars will be running over all the lines controlled by the Brooklyn Heights Company. A number of the car houses will be converted into branch express offices, and the main express office will be situated in the old Brooklyn City Railroad Company's building, near Fulton ferry. Wagons will be sent to any address, and goods will be taken to a branch express office, and thence transported by trolley to other branch offices, from which other wagons will deliver them. It is expected that every express wagon now running in Brooklyn will be secured for the new service.

**A system** of automatic fog signaling on board ship was exhibited recently in the St. Katherine docks, London. It is an arrangement designed by Mr. F. H. Berry, for automatically giving the bell and whistle signals required of a ship in a fog. The apparatus by means of electricity not only sounds the bell or blows the whistle at the necessary intervals, but also leaves a permanent record of the time in red and black inks on a strip of paper. Both the frequency and the duration of the signals can be easily regulated. It is thought that an apparatus controlled by clockwork is likely to give signals at more accurate intervals than could be obtained by human agency, while in cases where collision has occurred the record provided by the machine might often be of considerable aid to the court in apportioning the blame between the ships concerned.

**Officers of the** Brooklyn, Queens County and Suburban branch of the Brooklyn Heights Railroad Company's system have been engaged for several months in efforts to find out who is responsible for the stealing of electricity from the company's wires, which they believe has been going on for an indefinite length of time in various parts of the city, says the Home Journal. They have had the proprietor of a saloon, whose place they aver was lighted by stolen electricity, arrested, and they declare that they have evidence against half a dozen other places where stolen electricity has been used for illumination. Scores of shops might be lighted in this way for a long period without detection, and the company is determined to punish everybody caught robbing it. Besides the railroad company, the gas and electric light companies are interested in the efforts to get at the offenders, since the use of stolen electricity for illumination deprives one or the other of them of revenue.

**The German Hygienic Association** offers a prize of $1,200 for a research essay on the efficiency of electric heaters. The programme is as follows: "The heat given out in heating installations by heaters in their various forms and modes of use is to be ascertained. The investigations are to be described in detail in respect to the arrangement of the heaters, the nature of the heating agents, and the observations made; and they are to be illustrated by drawings. The heating values obtained are to be stated in units of heat given off per hour per unit of surface. In the case of heat given out to air, the investigations must be conducted with currents of air at speeds as different as possible. The heaters are to be described in detail as regards form and measurement, and the relation of their heating efficiency to their weight is also to be ascertained." Essays are to be written in German, and sent, with a motto and sealed envelope, to Prof. Konrad Hartmann, Charlottenburg, Fasanstrasse 18, before July 1. The essay will remain the property of the successful competitor, but he is required to publish it within six months, and to give the prize offerers gratuitously 300 copies. The offerers reserve the right to divide or withhold the prize.

## MISCELLANEOUS NOTES.

**A discovery** of alum has been made in the Lower Umzimkulu district of Natal.

**It is said** that an orange 16 inches in circumference was taken from a tree at Pomona, Cal. It is to be sent to Europe as a specimen of California fruit.

**Marseilles is** running Lyons close for the place of second city of France. The new census shows that Lyons has 467,000 inhabitants and Marseilles not quite 440,000.

**The Atlanta** Exposition buildings, at Piedmont Park, Atlanta, Ga., are to be retained and purchased by the city. The city councils have appropriated $4,000 annually for their maintenance.

**The Wochenschrift** fur Brauerei shows that, taking into consideration not the quantity of beer, wine, etc., consumed in various countries, but the proportional amount of alcohol, the countries of Europe rank as follows: Belgium, 11·68 liters per head per annum; France, 11·12; Denmark, 10·30; Germany, 9·01; Great Britain, 8·73; Switzerland, 7·90; Austria-Hungary, 7·09; Holland, 6·14; Russia, 5·15, etc.

**A Manchester** photographer relates that he recently took a photograph of a child who was apparently in good health and had a clear skin. The negative showed the face to be thickly covered with an eruption. Three days afterward the child was covered with spots due to prickly heat. The camera had seen and photographed the eruption three days before it was visible to the naked eye. It is said that another case of a similar kind is recorded, where a child showed spots on his portrait which were invisible on his face a fortnight previous to an attack of smallpox.

**Interesting results** are arrived at if it is figured out how much water is lost by the leaking of a faucet from which water escapes in drops if the washer is not tight. A chemist, who measured exactly the amount of waste, found that about 50 drops fell every minute; within 90 minutes there would be 4,500 drops of water, which is equivalent to a quart, so that there would be a loss of 4 gallons of water every 24 hours. In a year almost 1,500 gallons of water will have been wasted uselessly from such a faucet. It is considered that leaking faucets are quite frequent, and the immense waste of water becomes more apparent.—American Builder.

**The recurring** indisposition of the Pope has again raised the question of heating the Vatican, a problem which, so far, has never yet been satisfactorily solved. There are no fewer than 11,000 rooms in the Papal palace, and many of them never receive a ray of sunlight. Prof. Laponi, the physician of his Holiness, has tried by all the means in his power to maintain a normal temperature in the private apartments, but without effect, and they remain much too cold for the daily diminishing vitality of the Pope. An architect recently submitted a plan for distributing hot air all through the Vatican, but when the cost was mentioned—$180,000—the Pope dismissed the subject with a wave of the hand.

**A ton of** coal yields on an average 27 or 28 pounds of sulphur. On a cold day in London, England, they consume 401,000 tons of coal, so that they are day by day polluting the air they breathe by the admixture of 500 tons of sulphur, nearly every atom of which is food for the demon fog. This is incurable. No way seems to be devised by which they can burn coal and get rid of the sulphur, no system of filtration to stop the deleterious and let the harmless products pass. There is reason to believe that the worst features of their fogs are those that spring from preventable causes. They are all offenders; the head and front of their offense being that they only half burn their coal. It is the imperfect combustion of their coal that causes the black or "pea soup" fog, which doubles the mortality from asthma and trebles the death rate from bronchitis.

**The time** honored scheme of rolling up a piece of paper and using it for a lighter has been utilized by an inventor in the manufacture of matches. The invention promises to revolutionize European match manufacturing, and is particularly timely, because the wood for this purpose is constantly growing scarcer and more costly. The new matches are considerably cheaper than wooden matches and weigh much less, a fact which counts for much in the exportation. The sticks of these matches consist of paper rolled together on the bias. The paper is rather strong and porous, and when immersed in a solution of wax, stearine and similar substances, will easily stick together and burn with a bright, smokeless and odorless flame. Strips ½ inch in width are first drawn through the combustible mass spoken of above, and then turned by machinery into long, thin tubes, pieces of the ordinary length of wood or wax matches being cut off automatically by the machine. When the sticks are cut to size, they are dipped into the phosphorus mass, also by the machine, and the dried head easily ignites by friction on any surface.

**Frank W. Birchall**, in the India Rubber World, inclines to the theory that the oxidation of caoutchin is one of the causes of cracking of rubber goods. This caoutchin is soluble in chloroform, but precipitates on adding alcohol. Vulcanization does not diminish its affinity for oxygen. The compounds used in rubber tend to fill its pores and lessen the opportunities for oxidation somewhat, but substances introduced in the compound are often injurious. Examples are given of injury to the rubber due to antimony sulphide which contained sulphuric acid, and in another case to a vulcanizing compound which contained moisture. Excess of sulphur over the amount necessary to vulcanize is liable to cause "bloom" on the finished goods. This may be removed by boiling in caustic soda, but this operation may injure the goods. Oxidizable oils are objectionable in rubber compounds, as the oxidation may go too far. Metallic oxides added for coloring purposes, or left in the cloth after dyeing, may cause injury to the rubber. A table of analyses of sound and damaged rubber shows very large increase in the percentage of oxygen and some loss of carbon and sulphur. The author expresses the hope that rubber may be synthetically produced in the near future.

[Continued from SUPPLEMENT, No. 1067, page 17060.]

## COAST AND LIGHTHOUSE ILLUMINATION IN FRANCE.

By C. S. DU RICHE PRELLER, M.A., Ph.D., Assoc. M. Inst. C.E., M.I.E.E., in London Engineering.

5. LIGHTSHIPS, Luminous Buoys, and Fog Signals.—Floating lights carried on lightships and luminous buoys may be regarded as subdivisions of fixed, occulting, and flashing lights, while fog signals serve as accessories of lighthouses situated at headlands, on important landfalls, or island stations.

The lightships on the French coasts carry chiefly reflecting or catoptric apparatus, composed of eight to ten reflectors for the smaller fixed mineral oil lights of 80 to 480 candle power, having a diameter of 290 millimeters, while the apparatus of the largest revolving lights of 2,400 to 12,000 candle power (Ruytingen and Dyck, near Dunkirk and Gravelines) is composed of three groups of three reflectors, the diameter of the apparatus being 500 millimeters and the duration of the flashes five seconds, with intervening total eclipses of 15 seconds. The focus of the lights is placed at 10 to 14 meters (33 ft. to 46 ft.) above water level, their geographical range being about equal to their luminous range, viz., 12 to 13 nautical miles, assuming the eye of the observer to be at 20 ft. above water level. The mineral oil used in these lights has a flashing point of 50 deg. Cent. or 122 deg. Fah., as used in all the coast and harbor lights under the charge of the French boat type (2 cubic meters = 71 cubic feet); and the fourth or special type (16 to 18 cubic meters = 564 to 634 cubic feet). Figs. 19, 20, 21, and 22 show a buoy of each type. The focus is placed at an average height of 4 meters, or about 13 ft., and their visibility under average atmospheric conditions ranges, according to the candle power above mentioned, from 4 to 8 nautical miles. At certain points, they are placed in duplicate, or groups of two, to provide for the contingency of one of them failing. Of the 91 gas lighted buoys on the French and African coasts, 75 are placed near the shoals of Dunkirk and the Landes, and near the estuaries of the Seine, Loire, and Gironde, viz., 44 in the Channel and 31 in the Bay of Biscay, while in the Mediterranean there are only 16, of which 1 is on the Riviera, 5 on the Algerian and 10 on the Tunisian coast.* Permanent lights, requiring only periodical attendance, have also been introduced at twelve isolated and dangerous stations, and other points, notably at pier heads inaccessible during storms. In these cases, however, ordinary mineral oil is generally used instead of gasoline or compressed oil gas.

The fog signals on the French coasts are either sirens, formerly actuated by steam, but now almost exclusively by compressed air, or steam or air trumpets, horns, or bell signals. As already mentioned, the sirens serve as accessories to the lighthouses at headlands, important landfalls, and island stations, six electric lighthouses and two important mineral oil lighthouses in the Channel (Ailly and Antifer) being provided with them. The air was formerly compressed siren 12·5 centimeters (5 in.) in diameter being 5·5 miles, which may, however, in thick weather, be reduced to 2 miles. Of the foghorns, some are actuated by steam, and the more recent ones by compressed air.

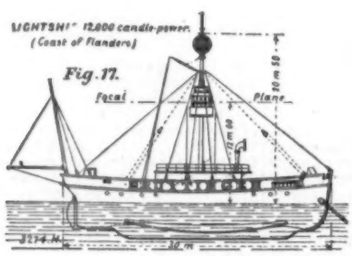
The number of sirens and of foghorns and bell signals on the coast of France (there being none in the Mediterranean) works out as follows:

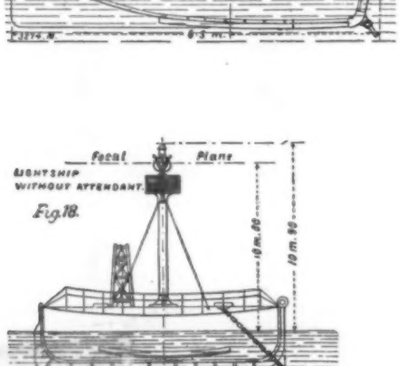
| | Sirens. | Fog Trumpets, Horns, and Bell Signals. |
|---|---|---|
| In Channel (Dunkirk to Ushant)... ..... ..... | 7 | 17 |
| In Bay of Biscay (Ushant to Biarritz)..... .. .. | 4 | 9 |
| | 11 | 26 |

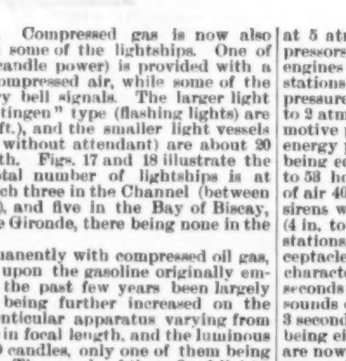
On the British coasts, the sirens are 47, and the other fog signals 151 in number, while the maximum energy of the siren blast, e. g., at St. Catherine's (Isle of Wight) is equal to 600 horse power.

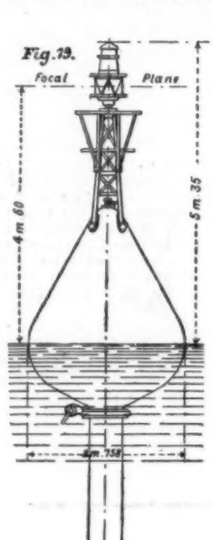
### LUMINOUS POWER.

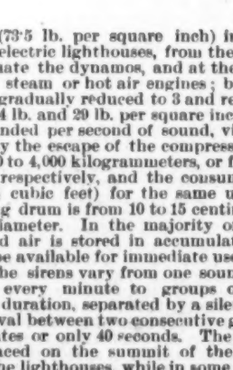
As the writer already pointed out in the paper on La Heve Electric Lighthouse, the French Lighthouse Department, in determining the actual luminous power of their coast lights, do not rely on any formulæ, but exclusively on accurate and exhaustive photometrical tests which are carried out for every apparatus and for its illuminant, at the Central Dépot des Phares in Paris, the photometric method being similar to that adopted during the South Foreland experiments

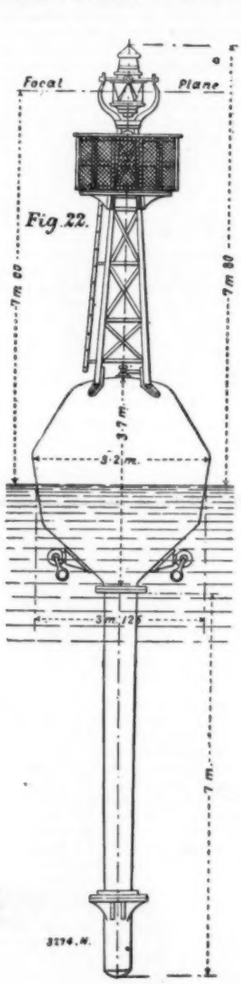



Lighthouse Service. Compressed gas is now also being introduced on some of the lightships. One of the lightships (2,400 candle power) is provided with a siren worked with compressed air, while some of the other lightships carry bell signals. The larger light vessels of the "Ruytingen" type (flashing lights) are about 30 meters (100 ft.), and the smaller light vessels (gas lighted, with or without attendant) are about 20 meters (66 ft.) in length. Figs. 17 and 18 illustrate the two types. The total number of lightships is at present eight, of which three in the Channel (between Dunkirk and Calais), and five in the Bay of Biscay, near the mouth of the Gironde, there being none in the Mediterranean.*

Buoys lighted permanently with compressed oil gas, as an improvement upon the gasoline originally employed, have within the past few years been largely introduced, and are being further increased on the French coasts, the lenticular apparatus varying from 100 to 150 millimeters in focal length, and the luminous power from 10 to 80 candles, only one of them being of 4,000 candle power. The supply of these fixed lights, left to themselves, has been tested to last as much as 150 consecutive nights and days, the usual time for replenishing them being, in practice, three weeks. The luminous buoys are of four types: one the ordinary type, varying in gas capacity from 4 to 11 cubic meters (141 to 388 cubic feet); the second or flat bottom type (4·8 cubic meters = 170 cubic feet); the third or at 5 atmospheres (73·5 lb. per square inch) in compressors driven, at electric lighthouses, from the steam engines which actuate the dynamos, and at the other stations by special steam or hot air engines; but the pressure has been gradually reduced to 3 and recently to 2 atmospheres (44 lb. and 29 lb. per square inch), the motive power expended per second of sound, viz., the energy produced by the escape of the compressed air, being equal to 3,000 to 4,000 kilogrammeters, or from 40 to 53 horse power respectively, and the consumption of air 400 liters (14 cubic feet) for the same unit, in sirens whose moving drum is from 10 to 15 centimeters (4 in. to 6 in.) in diameter. In the majority of siren stations, compressed air is stored in accumulator receptacles, so as to be available for immediate use. The characteristics of the sirens vary from one sound of 3 seconds duration every minute to groups of two sounds of the same duration, separated by a silence of 3 seconds, the interval between two consecutive groups being either 2 minutes or only 40 seconds. The sirens are now always placed on the summit of the outer cage or lantern of the lighthouses, while in some of the older lighthouses they are placed at distances up to 1,500 meters, or about one mile, from the engine house. The range of sound emitted by the compressed air sirens on the French coasts varies, according to the diameter, from 0·3 to 13 miles, the mean range of a of 1885. The former practice of determining the luminous power simply by calculation, according to M. Allard's or other formulæ, was abandoned when it was found that the first electric coast lights installed in France, according to M. Allard's programme of 1882, gave, by photometric measurement, only from 60 to 76 per cent. of their calculated luminous power, the considerable loss of about 35 per cent. being mainly due to the inevitable imperfections in the optical apparatus and to the more or less impaired atmosphere. A certain, though small, percentage of loss of power is also due to the absorption of light by the outer cage or lighthouse lantern, and further loss of power may be caused if the optical apparatus or the lantern are not kept scrupulously clean.

The photometric test is applied in France not only to all lenticular apparatus, viz., apparatus with dioptric (refracting) and catadioptric (refracting and reflecting) lenses, but also to catoptric (reflecting) apparatus. As is known, the luminous power of all lenticular apparatus, whether fixed or revolving, is, as a rule, constant, while in reflecting apparatus whose beam is not limited by screens, the luminous power diminishes the more the observer moves away from the axis, and when the light is revolving, e. g., in certain floating or lightship lights, the intensity of the beam or flash begins at a minimum, gradually reaches its maximum, and then again drops gradually to the minimum.

From an analysis of the official list already quoted, the tested luminous power of the coast and harbor lights of all descriptions on the coasts of France,

* The light vessels on the British coasts considerably exceed these on the French coasts, both in number and in luminous power, there being 79 light vessels, with a maximum power of 16,000 candles per light vessel.

* The luminous buoys on the British coasts are not included in the Admiralty List; there are at present 39 on the coasts of England, 6 on those of Scotland, and none on those of Ireland, total 28. The number of ordinary buoys is 582, 117, and 73, respectively, total 722 on the British and 642 on the French coasts.

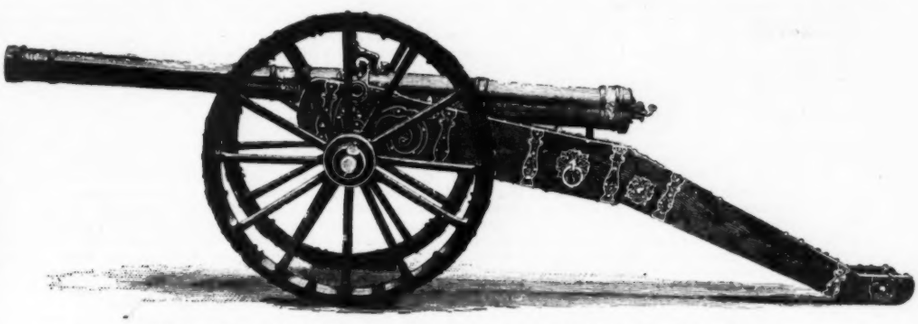
Corsica, Algiers, and Tunis may be shortly stated as follows:

| | Focal Length of Apparatus. Mm. | Luminous Power in Standard Candles. |
|---|---|---|
| Fixed mineral oil and gas lights | 100 to 920 | 10 to 8,780 |
| Single and group flashing mineral oil lights | 150 " 920 | 350 " 85,000 |
| Lightning flash mineral oil lights | 250 " 920 | 12,000 " 190,000 |
| Hyper radiant mineral oil lights | 1,330 | 220,000 |
| Fixed electric lights | 300 | 120,000 |
| Single and group flashing electric lights | 300 | 600,000 to 6,500,000 |
| Single and group flashing lightning flash electric lights | 300 | 22,500,000 " 37,500,000 |

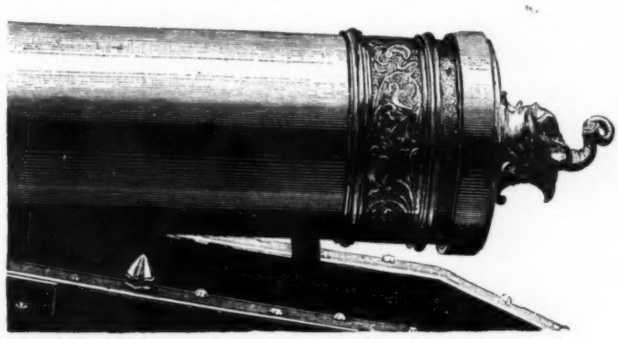
It should be mentioned that the only fixed electric lights now remaining on the coasts of France, viz., the two of La Canche, between Boulogne and Dieppe, and that of Palmyre, at the mouth of the Gironde, are in course of being replaced by electric (group flashing) lightning flash lights, a single light being substituted for the two La Canche lights. The hyper radiant apparatus of Cape d'Antifer is the only light of that type installed in France, as mineral oil lightning flash lights with smaller apparatus are more economical at the same luminous power. For the same reason the French Lighthouse Department has refrained from introducing the bi-form, tri-form, and quadriform system of superposed lenses with 10 wick burners adopted by the Trinity House and the Irish Lighthouse Board, an additional reason being that the French department does not consider it advisable to use more than six wicks in one lamp.

## THE GOLD CANNON IN THE ROYAL ARSENAL AT BERLIN.

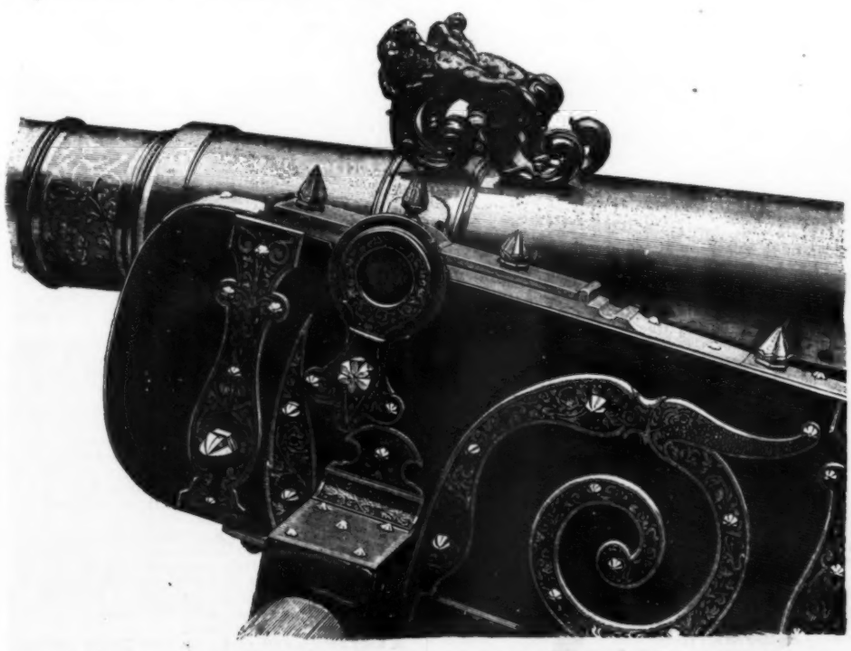
THE latest acquisition of the Royal Arsenal is the so-called "gold cannon." There is nothing of this kind in any of the European museums of arms, and the only similar cannon in the world, so far as we know, is the one still left in Hamburg, where this one was obtained. The barrel, which is nearly 10 feet long, is brilliant with fire gilt, and is decorated with three chased bands of designs of leaves besides the raised rings and bands. The two handles represent nude wrestlers and the plug at the end is in the form of an elephant's head. The carriage is equally beautiful; it is made of oak veneered with polished pear wood and is ornamented with bands, bolts and rosettes of bright iron covered with beautifully engraved designs of flowers. By filling the background with a black mass the white flowers are thrown out sharply. The still unexplained mark of the etcher, H. R. M. 1643, occurs twice. The construction of the barrel is remarkable, because it is unique; it is not described in any handbook, nor is anything similar to be found anywhere. It consists of a copper tube formed of two shells, between which, as a filling, is a cylinder of pine wood covered with leather. The bore is 2·5 inches in diameter. At the end of the barrel there is a central touch hole which is closed by the plug above referred to. From an artistic standpoint the model is unparalleled, although the maker was forced by the serious purpose of the weapon to restrict his desire to indulge in artistic forms. Unpractical forms and extravagance of decoration, such as are seen to-day on many articles of common use, were excluded because they would have been inconsistent; although artistic decorations were more frequently found on weapons than on other objects. The origin of these two guns is still unknown, but they were often spoken of in the seventeenth and eighteenth centuries. According to historical accounts, they were seized from a Hamburg merchant long before 1675, for debt. Artistic considerations lead to the conclusion that these barrels were manufactured in Holland, and there is no doubt that work of such an unusual kind was done only by order. Who ordered it? Involuntarily one thinks of the great elector, who was in Holland shortly before 1643, and who took more interest in artillery, which he altered and improved, than any other princes of his time. It may be that the gun was ordered in Holland, and consigned to the Hamburg merchant from whom it was seized for the debt which he owed the senate. Emperor William has shown the greatest interest in the new ornament of the arsenal.—Ueber Land und Meer.



THE GOLD CANNON IN THE ROYAL ARSENAL AT BERLIN.
From photographs by Zander & Labisch.



DECORATION OF THE BARREL.



SIGHT AND DECORATION OF THE CARRIAGE.

## WHAT IS BITUMEN?*

By S. F. PECKHAM.

THE exact meaning of the word "bitumen," in modern scientific literature, has been a matter of perplexity for many years. It has appeared to me impossible that any one unacquainted with the different substances included by the makers of dictionaries and cyclopedias under their descriptions and definitions could form any clear idea of what they are. For instance, in Genesis xi. 3, a Hebrew word occurs which designates the substance used in constructing the walls of the tower of Babel. In the Septuagint this word is translated ἄσφαλτος, and in the Vulgate, "bitumen." In the Bishops' Bible of 1568, and subsequent translations into English, the word is rendered "slime." In the Douay translation of 1600 it is "bitume." In the Protestant French translation it is "bitume." In Luther's German Bible it is "thon." In removing the magnificent alabaster slabs that were used to adorn the palaces of Nineveh and Babylon, it has been discovered that the material used to cement and hold the slabs in position was melted or natural maltha. The word "asphaltum" is said to be derived from α. privitive, and σφαλλο, "I cause to slip." It therefore signifies a substance that prevents one from slipping, and was applied to the solid forms of bitumen that soften in the sun. This substance was not rare in so-called Bible lands, embracing the valley of the Euphrates, the table lands of Mesopotamia and the valley of the Jordan. It was of frequent occurrence along the shores of the Dead Sea, and was gathered and sold in the caravan trade that passed through the land of Moab and Petrea into Egypt.

During the Middle Ages, asphaltum and other forms of bitumen appear to have found but few uses, and they are but seldom mentioned. The words bitumen, asphaltum, petroleum, and naphtha appear to have been used with different meanings, and also interchangeably or synonymously; yet the words were generally used to signify a thing that was located and defined by further description, so that the bitumen of the Dead Sea was recognized as asphaltum, or solid bitumen; that of Zante, as petroleum, etc. It is only within the last century that any serious confusion in nomenclature has appeared, and then the trouble has arisen out of commercial rather than scientific considerations. About the year 1830 the French schist oil began to assume importance. Later, the Scotch paraffin industry arose, and during the decade from 1850 to 1860 extended from Scotland to the United States, into which both the materials used and the methods of manufacture were imported. In France the materials used were properly called "the bituminous shales of Autun." In Scotland the material was called boghead coal, boghead shale and boghead mineral; it was also called torbanite. The expense attending the importation of the boghead shale into the United States led the Downer Kerosene Oil Company, of Boston, Mass., and Portland, Me., to make an exclusive contract for the use of the albertite, of New Brunswick. It was called Albert coal, asphalt, pitch, etc., and for commercial reasons, became the subject of a very important lawsuit, in which, as experts, scientific men gave very conflicting testimony, one party claiming that the material was asphaltum, and the other that it was coal. It was finally decided that the material was not coal, and did not belong to the Crown.* At about this time, a deposit occurring in West Virginia, and since known as grahamite, and which, in appearance, is much more like splint coal than albertite, attracted attention. There were veins of material in Cuba that were also included in the argument, coal vs. asphalt.

The word "petroleum" assumed commercial importance about the year 1860 as designating certain natural oily fluids obtained from springs or wells, and that, by refining, could be converted in large part into illuminating oils. At about the same time the solid bitumen of the island of Trinidad began to attract attention as a possible crude material for the same purpose. It was only as late as 1865 that the petroleum mania became general, and that the interest in the contest, coal vs. asphalt, was allowed to subside. At that time nearly every bitumen spring in the world became the center of developments for the production of petroleum by artesian borings. The result was the introduction into commerce of many grades of petroleum that were chiefly distinguished by differences in density and the amount of oils of certain

* Read before the Chemical Section of the Franklin Institute, October 15, 1895.

* Taylor's Statistics of Coal, Philadelphia, 1855, p. 516. Taylor's deposition before the Supreme Court at Halifax, N. S., respecting the asphaltum mine at Hillsborough, Philadelphia, 1851. On a New Variety of Asphalt, C. M. Wetherell. Trans. Am. Philos. Soc. (N. S.), 10, 353.

specific gravities, and suitable for certain purposes, chiefly illumination, to be obtained from them.

The researches of Pelouze and Cahours* and Warren and Storer showed that the Pennsylvania petroleums examined by them consisted chiefly of paraffines and isoparaffines, the lowest member of which is marsh gas.† Although I had shown in 1868‡ that the Pacific coast petroleums contained a notable percentage of nitrogen, and that they could not be made to yield illuminating oils equal in quality to those obtained from Pennsylvania petroleum; also, that asphaltum and maltha were products of the decomposition of these petroleums from natural causes; nevertheless, some of the ablest writers on petroleum continued to speak of the "petroleum springs of the Southwest," as though petroleum, maltha and asphaltum had never been defined, and millions of dollars had not been lost in attempts to obtain petroleum, as it was then known in Eastern commerce, in the valleys of Southern California, and to refine it into the best qualities of burning oils. In the fall of 1865, Drs. John Torrey and C. T. Jackson visited the center of operations on the Ojai§ Ranche, now known as the Upper Ojai, and described as "a petroleum cascade" a hillside where a stream of maltha issued high up toward the crest of the Sulphur Mountain, and, spreading in the sun, trickled over several hundred feet of shale precipices. Any one ascending to the crest of the Sulphur Mountain, by the road leading from the Upper Ojai, can now see the same thin stream of maltha glistening in the sun, as it appeared to Messrs. Torrey and Jackson. As I saw it a year ago, there had been no apparent accumulation of material in twenty-nine years.

The wrangle over the question whether there was any petroleum in Southern California at all was carried on with great bitterness in 1864–65. It was really a wrangle over words more than things, for at that time practically no petroleum worth mentioning had been found in Southern California—only just a little, enough to give a color of truth to the assertion that it was found there, thus making it possible to impose on Prof. Silliman, as was done.

I have lately reread the report that I made to the California Petroleum Company in January, 1866, and find that I then supported my statements that the bitumen of that region was maltha, and not petroleum, by references to Dana's "Mineralogy" and Dr. Ure's "Dictionary of Arts, Manufactures and Mines." These works were then well known, and had been printed many years. I thus proved that maltha was no newly discovered substance, and that, like petroleum and asphaltum, it had long been known and described. These definitions are not confined to the English language, but are just as well recognized in both the French and German languages.

It therefore appears to me to be quite worthy of careful consideration that, within the last five years, a patent case should have obtained any standing at the Patent Office or before the courts of the United States, wherein the only real point at issue was the continued misuse and misconstruction of the word bitumen and the species under it.

The history of the case was as follows: One Beardsley, who was in Southern California when I was there in 1865, patented a process for smearing paper with hot residuum from the distillation of California petroleum. As described by him, the material might also be purified asphaltum, obtained by dissolving asphaltum in petroleum, allowing the dirt to settle and distilling to a residuum the solution thus obtained. If he had called his residuum "asphalt," as others do, the patent would have been rejected; so he called it "maltha," and described it as the "solid residuum of heavy petroleum." He might just as well have called it "butter," or "guava jelly," and have defined it as he did, for no such definition of the word maltha was ever given before. This patent was allowed and issued. Then he applied for another patent on an operation that consisted in dissolving his "maltha" in carbon disulphide and applying the solution to paper. This patent was also issued, probably for the reason that the Patent Office officials did not understand the misuse of the word "maltha," and thought that a new substance was being dissolved in carbon disulphide. After various commercial evolutions, these patents became the property of the Paraffine Paint Company, on the Pacific coast, and of the Standard Paint Company, of New Jersey, in the Eastern States. They obtained their "maltha" from the Union Oil Company, of California, whose works are located at Santa Paula, Ventura County, Cal. After a time, one H. J. Bird commenced the manufacture of coated paper by applying a mixture of Trinidad pitch, Carnauba wax, wax tailings and coke pitch, neither of which was Beardsley's "maltha" or any other maltha. Meantime, the Standard Paint Company began using coke pitch, a well-known commercial product, obtained as a residue from the destructive distillation of petroleum tar. The case was brought against Bird for infringement, and has just been decided in Bird's favor, from first to last, by the full bench of the United States District Court, sitting at Trenton, N. J. The case was in litigation five years and ruined Bird financially.

The ground of contention was that coke pitch, being a residuum of petroleum, was Beardsley's "maltha." While the word maltha was well known to mean "mineral tar," and had had that meaning for an indefinite period, it was claimed that the action of the Patent Office in granting Beardsley's patent had "fixed the meaning of the word 'maltha' for the purpose of coating paper;" hence, Bird infringed, although he used a mixture of four substances, in neither of which was Beardsley's "maltha" as used by him. A noted expert maintained that Bird's mixture was identically the same thing as Beardsley's "maltha," because both were black, shiny, had a conchoidal fracture, and were tasteless and odorless. Since the confusion of tongues at Babel, no such confusion of names and things and mixtures of things was ever witnessed as, in this case, confounded all forms of bitumen, and all of the artificial products having properties similar to, or identical with, natural bitumens. And yet, in spite of a vigorous and able defense, it was allowed to drag along for years in an attempt to monopolize a business where invention can only apply new materials by an old process long since exhausted of patentable elements.

Again, the Bibliothèque Scientifique Internationale has just issued a posthumous work by the late eminent Swiss geologist, August Jaccard. The work is entitled "Le Petrole, l'Asphalte et le Bitumen,"* a title in which the species is made to include the genus. The work presents the subject "au pointe de vue geologique," and for this reason many errors and defects may be overlooked from the standpoint of other branches of science. The book seeks the plane of the general intelligent reader, and despite the many grave defects that I have elsewhere pointed out, has much to recommend it; yet, in respect to the nomenclature of its principal subject, "bitumen," it is particularly and unfortunately confused. Indeed, I do not see how a person who is not to some extent familiar with the subject, and who, therefore, reads with considerable discrimination, can clearly understand the meaning of many passages. The entire nomenclature of bitumen is used with such a confusing disregard of clear distinctions—the same word being used in different places with a different meaning—as to detract much from descriptions otherwise of great value, for there is probably nowhere to be found so complete a resume of the literature extant relating to the asphaltic limestones of the upper valley of the Rhone.

It therefore seems to me desirable that the word bitumen should be once more, and clearly, defined, as the generic name of that large class of substances occurring in nature as minerals, and consisting chiefly of mixtures of compounds of carbon and hydrogen, with nitrogen, sulphur and oxygen as more rare constituents. Under this genus should be ranged, as species and subspecies, all of the natural combustible gases, naphthas, petroleums, malthas and asphaltums.

These gases include free hydrogen, carbon monoxide and all of the initial members of the different series of hydrocarbons that have been found in petroleums, together with others in each series that exist as free gases at comparatively low temperatures. These natural gases are not constant in composition, even when issuing from the same spring or well; nor are they found to be alike in composition when gases from localities yielding essentially unlike varieties of bitumen are compared. It would, therefore, be a fruitless task to attempt to give a name to natural gas as a mineral species that was in any manner derived from the chemical composition of any particular specimen of gas. It can only be described as a gaseous form of bitumen, distinguished from other natural gases by being combustible.

The word naphtha is said to be derived from the Persian word nafta, and was originally used in Western Asia to designate certain fluid forms of bitumen that have an ethereal, rather than an oily consistency. In those localities, notably Asia Minor and Persia, where this class of bitumens abound, the name "naphtha" was applied to all of the fluid forms of bitumen. From this source the word passed into Europe, where, until quite lately, it was generally used instead of petroleum. Practically, in the languages of modern Europe, the words naphtha and petroleum are synonymous, as applied to the fluid forms of bitumen.

(To be continued.)

* Compt. Rend., 56, 505; 57, 62. Annales de Chimie et de Physique, (4) 1, 5.

† Mem. Am. Acad., N. S., 9.

‡ Proc. Am. Philos. Soc. (N. S.), 10, 445.

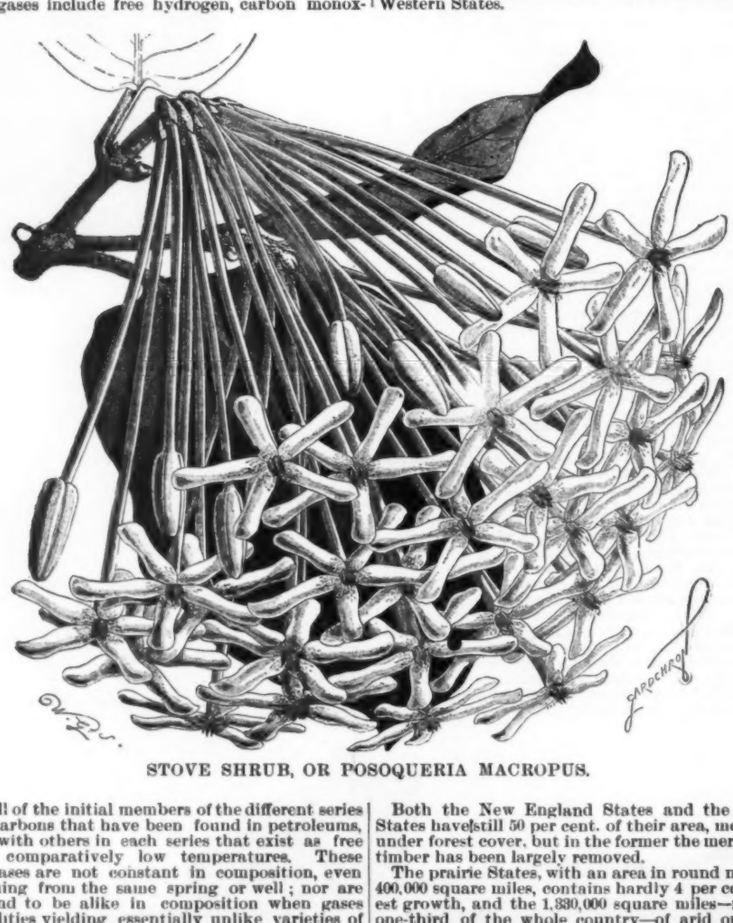
§ Ojai, pronounced O-hi.

* Le Petrole, l'Asphalte et le Bitume, par A. Jaccard, Paris, Germer Balliere et Cie, 1895.

It has been found that a very low temperature at 400° below zero produces a remarkable effect on colors, for instance, the brilliant scarlet of vermilion and mercuric iodide is reduced to a pale orange. When the temperature rises, the original color is gradually restored. Blue colors are apparently unaffected by cold and the effect is comparatively small on all organic coloring matter of all tints.

## STOVE SHRUB—POSOQUERIA MACROPUS.

THE magnificent stove shrub of which we give an illustration is a native of Brazil. It was sent to us under the name of P. longiflora, but the characters afforded by the tube of the corolla and the base of the leaf are not those of the Guianan longiflora. The name Posoqueria is, it appears, derived from the Carib name, signifying poisonous. Whether it is so or not is doubtful. The plant belongs to the great order Rubiaceæ and is allied to Gardenia, the mode of culture required for the one being suitable for the other. The plant was shown at the last meeting of the Royal Horticultural Society by Messrs. Balchin & Son, who obtained for it a first-class certificate.—Gardeners' Chronicle.



STOVE SHRUB, OR POSOQUERIA MACROPUS.

## FOREST RESOURCES OF THE UNITED STATES BRIEFLY STATED.

THE following data regarding the extent, condition, and consumption of our forest resources have been compiled by Mr. B. E. Fernow, Chief of the Division of Forestry, United States Department of Agriculture, to answer frequently recurring inquiries.

There are no forestry statistics in existence. Even the census figures referring to the lumber industry are avowedly imperfect and based on partial returns. The data given, therefore, are only approximations and must be taken with that reserve.

The forest area of the United States (exclusive of Alaska) may be placed at somewhat less than 500,000,000 acres. This does not include much brush and waste land which is, and will remain for a long time, without any economic value. This area is very unevenly distributed; seven-tenths are found on the Atlantic side of the continent, only one-tenth on the Pacific coast, another tenth on the Rocky Mountains, the balance being scattered over the interior of the Western States.

Both the New England States and the Southern States have still 50 per cent. of their area, more or less, under forest cover, but in the former the merchantable timber has been largely removed.

The prairie States, with an area in round numbers of 400,000 square miles, contains hardly 4 per cent. of forest growth, and the 1,330,000 square miles—more than one-third of the whole country—of arid or semiarid character in the interior contain practically no forest growth economically speaking.

The character of the forest growth varies in the different regions. On the Pacific coast hardwoods are rare, the principal growth being coniferous and of extraordinary development. Besides gigantic redwoods, the soft sugar pine and the hard bull pine, various spruces and firs, cedars, hemlocks, and larch form the valuable supplies.

In the Rocky Mountains no hard woods of commercial value occur, the growth being mainly of spruces, firs, and bull pine, with other pines and cedars of more or less value.

The Southern States contain in their more southern section large areas occupied almost exclusively by pine forest, with the cypress in the bottom lands; the more northern portions are covered with hard woods almost exclusively, and intervening is a region of mixed hard wood and coniferous growth, spruces, firs, and hemlocks are found in small quantities confined to the mountain regions.

The Northern States are mainly occupied by hard wood growths, with conifers intermixed, sometimes the latter becoming entirely dominant, as in the spruce forests of Maine, New Hampshire, or the Adirondacks, and here and there in the pineries of Michigan, Wisconsin, and Minnesota, or in the hemlock regions of Pennsylvania and New York.

A very rough and probably very liberal estimate of the amounts of timber standing in the various regions ready for the ax would give the following figures:

| | Feet, B. M. |
|---|---|
| Southern States | 700,000,000,000 |
| Northern States | 500,000,000,000 |
| Pacific coast | 1,000,000,000,000 |
| Rocky Mountains | 100,000,000,000 |
| Total | 2,300,000,000,000 |

The total annual cut, including all material requiring bolt or log size, is estimated at 40,000,000,000 feet, B. M. It is made up of the following kinds:

| | Feet, B. M. |
|---|---|
| White pine | 12,000,000,000 |
| Spruce and fir | 5,000,000,000 |
| Hemlock | 4,000,000,000 |
| Longleaf pine | 4,000,000,000 |
| Shortleaf and loblolly | 3,000,000,000 |
| Cypress | 500,000,000 |
| Redwood | 500,000,000 |
| All other conifers | 1,000,000,000 |
| Total conifers | 30,000,000,000 |
| Oak | 3,000,000,000 |
| All other hard woods | 7,000,000,000 |
| Total | 40,000,000,000 |

In this cut the various regions participate in the following proportions:

| | Feet, B. M. |
|---|---|
| New England and North Atlantic States | 6,000,000,000 |
| Central States | 5,000,000,000 |
| Lake region | 13,000,000,000 |
| Southern States | 10,000,000,000 |
| Pacific States | 4,000,000,000 |
| Miscellaneous | 2,000,000,000 |

The consumption of fuel to the extent of probably 180,000,000 cords, of fence material, etc., the waste in the woods and at the mills, and loss by fire, brings the total annual wood consumption of the United States easily to 25,000,000,000 cubic feet, or 50 cubic feet per acre, a figure nearly corresponding to the yield per acre realized in the well kept forests of Prussia, where reproduction is secured by skillful management.

The consumption increases from decade to decade in greater proportion than the population; and new industries, like the wood pulp industry, add constantly to the demand.

The value of forest products used in the census year 1890 was estimated to exceed $1,000,000,000.

The items making up this grand total may be classified as follows, always keeping in mind that only approximations to actual conditions are here attempted. These figures are based in part on census statistics, in part on other estimates, and remain fairly representative to date (1895):

| | |
|---|---|
| Mill products, lumber, shingles, implement and furniture stock, etc | $450,000,000 |
| Railroad construction | 45,000,000 |
| Export timber | 5,000,000 |
| Wood pulp | 5,000,000 |
| Miscellaneous bolt sizes | 50,000,000 |
| Total materials requiring log and bolt sizes | 555,000,000 |
| Fuel and fencing | 450,000,000 |
| Charcoal | 7,000,000 |
| Dyewood and gunpowder | 500,000 |
| Naval stores | 8,500,000 |
| Wood alcohol and acetic acid | 2,500,000 |
| Tanning material | 15,000,000 |
| Maple sirup and sugar | 5,500,000 |
| Grand total | 1,044,000,000 |

The imports of wood and other forest materials amount to between twenty and thirty million dollars annually, about 25 per cent. of which consists of materials which do not grow on this continent. The balance comes mainly from Canada.

The exports of forest products and partly manufactured wood materials varies between twenty-five and thirty million dollars, with twelve to fifteen million more of manufactures in which wood plays an important part.

Although many of the great staples have in some regions been entirely exhausted and in others approach exhaustion, prices of lumber have not advanced in proportion, for various reasons. Competition, stimulated by active railroad building, opening up of virgin fields of supply, improved machinery, systematized methods of logging and of handling and marketing material have tended to keep the price down.

Meanwhile stumpage has increased rapidly for such kinds as show rapid decrease in supply. Thus white pine stumpage more than doubled in ten years, while walnut, tulip, poplar, and ash stumpage has increased many fold as the supply has grown scarcer.

In the markets, while the average price for lumber has advanced but little, the better grades have appreciated disproportionately. From the carefully collected statistics for shipbuilding, which requires all first-class material, the average price per 1,000 feet, B. M., for the country at large for the following kinds appears:

| Kind. | Average. | Lowest. | Highest. |
|---|---|---|---|
| White oak | $30.70 | $19.00 (Indiana) | $125.00 (California). |
| Other oaks | 34.90 | 20.00 (Indiana, Kentucky, West Virginia.) | 102.00 (California). |
| Hard pine | 24.40 | 12.00 (Alabama) | 42.00 (Iowa). |
| White pine | 34.70 | 20.00 (Minnesota) | 100.00 (Georgia). |
| Fir | 21.00 | 15.00 (Washington) | 80.00 (Mass.). |
| Spruce | 20.00 | 12.00 (Delaware) | 50.00 (Washington). |
| Cedar | 40.00 | 17.00 (Missouri) | 55.00 (Connecticut). |
| Cypress | 31.60 | 18.00 (Mississippi) | 50.00 (Delaware). |
| Average of all | 30.00 | | |

Firewood, even in the densely settled parts, remains stationary in price, on account of abandoned farms and culled woodlands producing it in abundance; in fact in many sections its value has decreased, competition of coal aiding in its reduction.

Census statistics of the employment of capital, persons employed, and wages paid in the minor forest industries are absent. The fact that many people are only temporarily or incidentally and for a part of the year engaged in the exploitation of the forest would make such enumeration wellnigh impossible. Besides the lumber industry and such kinds of exploitation as can be at least approximately enumerated—always remaining below the truth—a large number of industries and manufactures rely upon wood as the principal material, others employing it to a greater or less extent. An attempt has been made to classify these according to the estimated percentage of wood entering into their products, and assuming that capital, labor, and value of products add the same proportion to the total as the raw materials used. As a matter of fact, there is probably more labor employed in shaping wood than this percentage would indicate.

*Forest industries and manufactures using wood.*

| Articles. | Capital. | Employees. | Wages. | Raw material. | Value of product. |
|---|---|---|---|---|---|
| | *Thousands* | *Hundreds.* | *Thousands* | *Thousands* | *Thousands* |
| Forest industries enumerated: | $496,340 | 2,862 | $87,784 | $231,556 | $403,668 |
| Lumber and mill products | 61,541 | 461 | 11,354 | 11,007 | 34,290 |
| Timber products not manufactured at mill | 4,063 | 153 | 2,933 | 3,506 | 8,077 |
| Naval stores | | | | | |
| Total | 561,943 | 3,477 | 102,071 | 245,169 | 446,034 |
| Manufactures practically all wood: | | | | | |
| Cigar boxes | 3,374 | 55 | 2,134 | 3,567 | 7,092 |
| Packing boxes | 13,018 | 140 | 6,477 | 14,245 | 25,513 |
| Carriage and wagon stock | 13,026 | 109 | 5,208 | 1,388 | 16,262 |
| Carpentering | 81,543 | 1,409 | 94,524 | 137,847 | 281,195 |
| Cooperage | 17,817 | 247 | 11,665 | 2,637 | 38,618 |
| Furniture factory products | 66,394 | 639 | 34,471 | 38,796 | 94,871 |
| Kindling wood | 1,300 | 18 | 772 | 1,187 | 2,402 |
| Lasts | 907 | 8 | 572 | 331 | 1,239 |
| Planing-mill products | 120,271 | 869 | 48,970 | 104,927 | 183,682 |
| Matches | 1,941 | 18 | 344 | 935 | 2,194 |
| Wood, turned and carved | 7,826 | 84 | 4,267 | 3,947 | 10,940 |
| Woodenware | 2,712 | 31 | 1,237 | 1,499 | 3,598 |
| Wood pulp | 7,455 | 28 | 1,229 | 2,005 | 4,628 |
| Wood carpet | 333 | 3 | 155 | 214 | 512 |
| Total | 337,908 | 3,650 | 212,027 | 331,523 | 672,750 |
| Manufactures in which wood represents about 50 per cent of the raw materials: * | | | | | |
| Total | 169,983 | 1,356 | 714,480 | 114,383 | 229,408 |
| Wood percentage | 89,991 | 678 | 35,730 | 57,192 | 114,704 |
| Manufactures in which wood represents about 33⅓ per cent: † | | | | | |
| Total | 321,059 | 2,143 | 123,588 | 148,578 | 318,218 |
| Wood percentage | 107,019 | 714 | 41,196 | 49,526 | 106,072 |
| Manufactures in which wood represents about 10 per cent: ‡ | | | | | |
| Total | 76,841 | 915 | 46,854 | 49,291 | 131,820 |
| Wood percentage | 7,684 | 92 | 4,685 | 4,929 | 13,182 |
| Manufactures of wood: | | | | | |
| Total | 543,402 | 5,134 | 293,638 | 443,170 | 906,708 |

To get at an idea of the significance of the forest resource in the economy of the country and of the comparative position of the industries relying on forest products with reference to other industries, the following compilation will serve, being based on census figures for 1890:

*Leading industries compared.*

[Data from Census 1890, in round numbers.]

| | Capital involved. | Employees. | Wages. | Raw materials. | Products. |
|---|---|---|---|---|---|
| | *Millions.* | *Thousands* | *Millions.* | *Millions.* | *Millions.* |
| Agriculture | 15,982 | 8,288 | | | 2,460 |
| Forest products, total | | | | | 1,044 |
| Forest industries, enumerated | 562 | 348 | 102 | 246 | 446 |
| Forest products, not enumerated (estimated) | + | + | + | | 598 |
| Manufactures using wood (see table above) | 543 | 513 | 294 | 442 | 907 |
| Mineral products, total | | | | | 610 |
| Coal | 343 | 300 | 109 | | 160 |
| Gold and silver | 486 | 57 | 40 | | 99 |
| Iron and silver | 414 | 176 | 96 | 327 | 479 |
| Manufactures of iron and steel | 86 | 60 | 32 | 79 | 131 |
| Leather | 102 | 48 | 25 | 136 | 178 |
| Leather manufactures | 118 | 186 | 88 | 153 | 249 |
| Woolen manufactures | 297 | 219 | 77 | 203 | 338 |
| Cotton manufactures | 354 | 229 | 70 | 155 | 288 |

From this table it appears that agriculture standing first in capital, persons employed and value of products, the industries relying upon forest products stand easily second, exceeding in the value of products the mining industries by more than fifty per cent. The industries relying directly or indirectly on forest products employ readily more than one million workers (enumeration being imperfect), producing nearly $2,000,000,000 of value. The manufactures relying on wood wholly or in part more than double the value of the lumber or wood used, giving employment to more than half a million men and about equaling the combined manufactures of all woolen, cotton and leather goods in persons employed, wages paid and values produced.

The loss by fire varies from year to year, but is enormous, especially in the Western mountains, where it is impossible to ascertain the extent. An estimated annual loss of $25,000,000 in value seems in some years to be far exceeded. A recent careful canvass places the loss for Pennsylvania alone at $1,000,000 for the year. An estimate of the fire losses in Minnesota during 1894 places them at $12,000,000.

The principal centers of production of the leading commercial timbers of the United States may be briefly described as follows:

The white pine is distinctively a Northern tree, reaching its best development in Michigan, Wisconsin and Minnesota, where it is the dominant species. It was once the leading commercial species of Pennsylvania, New York and northern New England, but there it has been largely exhausted. In the South it is found only on the higher elevations of the Alleghanies and in limited quantities. The principal sources of supply at present are northern Wisconsin and Minnesota. In Michigan there are small tracts of virgin white pine forests, but over by far the greater part of the State not even a valuable second growth of white pine can be found.

Red pine, or Norway pine, is found associated with the white pine in its more northern habitat, and until lately was sold with the latter without distinction, although the lumber is very different, resembling more nearly the Southern shortleaf pine.

The bull pine (Pinus ponderosa) of the Rocky Mountains and the Pacific coast forms the main supply of hard pine for local use in the West, while the gigantic sugar pine of Oregon and California furnishes desirable soft pine material. Scattered here and there in small areas throughout the Western country, notably in Idaho, is found the mountain white pine (Pinus monticola), which is capable of being substituted for the other soft pines.

The longleaf or Georgia yellow pine occupies the coast plain from North Carolina to eastern Texas, being the dominant species over 100,000 square miles of territory. It reaches its greatest development in western Louisiana and eastern Texas.

The Cuban or slash pine, occupying a comparatively small territory near the Southern coast, is cut and sold without distinction with the longleaf pine.

The shortleaf pine region is adjacent to the longleaf pine region on the northern side, the two species intermingling where their areas join. The shortleaf pine, also known in the markets as North Carolina pine, has its botanical northern limit in Kentucky and Missouri, and on the Atlantic coast in New York, being there, however, of no commercial value. It reaches its highest development in Arkansas. High grade shortleaf pine lumber is cut in southern Missouri on a comparatively limited area. The principal centers of production are North Carolina, northern Alabama, northwest Louisiana, northeast Texas, and Arkansas. It occupies an area of about 70,000 square miles, but occurs scatteringly over a much greater area, and is of commercial importance in all the Southern States except Florida.

Loblolly or Virginia pine occurs throughout the longleaf region and the southern part of the shortleaf area. It is the principal species in Virginia and eastern North Carolina, and occurs in abundance along the Gulf coast. It is the "old field" pine of the Southern

States. Thus far it has been of much less importance as a source of lumber than the other Southern pines, but it is now extensively cut and often mixed with other pine lumber, the principal market being Norfolk, Va.

Spruce and Fir.—Maine, New Hampshire and northern New York are the principal sources of these timbers. Spruce occupies also considerable areas in the Alleghanies as far south as West Virginia. It forms, together with fir, part of the forest in the Black Hills and the Rocky Mountains. The lumber has taken the place of pine for joists and other light construction. Five-sixths of the annual cut of 1,500,000,000 feet in Maine is of spruce; 500,000,000 feet is used in the paper pulp industry yearly. Since 1853 the lumber industry has completely reversed its output. In that year the cut of pine on the Penobscot was 123,000,000 feet and of spruce 78,000,000 feet. In 1892 the cut of pine was 29,000,000 feet and of spruce 120,000,000 feet. In New York, of a total cut of 447,000,000 feet in the Adirondacks 334,000,000 feet were spruce and about 28,000,000 feet pine.

Douglas spruce (red fir, yellow fir) is the dominant species in the dense forests of western Washington and Oregon, forming about seven-eighths of the entire growth. It also occurs in quantities along the Rocky Mountains, especially in Idaho. Standing timber of all kinds in Washington is estimated at 410,000,000,000 feet, covering 23,500,000 acres. The cut of the State in 1892 was 1,440,135,000 feet, of which over 275,000,000 feet was in lath and shingles. Over 100,000,000 feet of lumber was shipped by rail to the East. The principal market is San Francisco, and over 100,000,000 feet was sold in 1892 to Australia, Hawaii, and South America.

Hemlock.—Pennsylvania and New York furnish the principal supply of hemlock lumber. The bark is used in tanning and the logs are sawed into lumber, for which there is a constant demand as a substitute for white pine in rough construction. Hemlock is found throughout the Alleghanies as far south as North Carolina and Tennessee.

Bald cypress occupies limited areas extending throughout the Southern States. The most extensive cypress region is in southern Louisiana and along the Mississippi and Yazoo Rivers in Mississippi, in the vicinity of Mobile, Ala., around Apalachicola, Fla., and along the South Atlantic coast. A limited quantity of cypress lumber is also cut in the lowlands of south Missouri, western Kentucky, and Tennessee and Arkansas.

Red Cedar.—This tree has the greatest range of any American species occurring from Florida to the State of Washington. The principal sources of supply are the forests of central and eastern Tennessee, northern Alabama, and Florida. The wood is used for hollow ware and the manufacture of lead pencils, and the mature trees are being rapidly thinned out. 5,000,000 feet of red cedar is used annually in the bucket factories. The pencil factories use about 500,000 cubic feet of soft clear material. No considerable area of red cedar for these manufactures exists anywhere in the country that has not been culled.

Redwood is found exclusively in the Coast Range of California, where the standing timber of this kind is estimated at less than 25,000,000,000 feet B. M.

Oak.—Among the fifty species of oaks included in our forest flora only about a dozen are commonly cut for lumber, and these are sold in the market under two names—white oak, of which Quercus alba, the species, is the type, and red oak, of which Quercus rubra is the typical form. According as the other commercial species more nearly resemble one or other of the species named, they are classed as "white" or "red." Formerly only the white oak was cut, as the wood was used almost exclusively for construction and for cooperage. Of late years oak has become a fashionable wood for furniture making and interior finish, and the red oaks are found quite as useful for these purposes and now have a recognized standing in the markets, though commanding a lower price than the white oaks. The red and white oaks are found in all American forests east of the Rocky Mountains, and originally large trees were common everywhere. The Northern forest has been more heavily culled than the Southern, so that now the principal sources of supply are the mixed forests south of the Ohio and Missouri Rivers, with Kentucky, Tennessee, and West Virginia probably in the lead. Arkansas forests are rich in oak, and the States of Minnesota, Wisconsin, Michigan, and Indiana supply a large demand. On account of the number of species, and the fact that the oaks only grow in mixed forests, no estimate of the standing timber can be made. The present annual cut is estimated at 3,600 000,000 feet, B. M., of which more than half comes from States south of the Missouri and Ohio Rivers.

Hickory.—This wood is used principally in bolt sizes for wagon stock. Like the oaks, several species are sold under the one commercial name, and the genus has a wide distribution throughout the Eastern forests. The principal sources of supply are Kentucky and Tennessee, though much good hickory is cut in Arkansas and West Virginia. The forests of Indiana, once the principal center of the hickory trade, are now largely exhausted. The annual cut is estimated at 250,000,000 feet.

Ash.—The principal source of supply of ash timber is western Tennessee and Kentucky, though tracts rich in ash are found in the rich mountain valleys of the eastern parts of these States and in West Virginia. Much ash is also cut in the hard wood forests of Michigan and Wisconsin. Memphis is the leading market for ash. The present annual cut is estimated at 350,000,000 feet, considerably less than was manufactured fifteen years ago.

Poplar.—The principal centers of poplar production are Kentucky, Tennessee, and West Virginia, though it occurs in greater or less abundance throughout the hard wood forests of the Ohio Valley. It never makes a pure forest, being scattered among other broadleaved kinds, and reaching its best development in the rich, moist valleys of western Tennessee. About 500,000,000 feet is cut annually.

Cottonwood.—The cottonwood attains its highest development in the moist, fertile bottom lands of western Tennessee and Mississippi, and in Arkansas. This species has the widest range of any broadleaved economic tree of the American forest, but commercially it is only important in the lower Mississippi Valley. Cottonwood has only recently made its appearance in the lumber trade, and much of it is still sold as poplar, there being a prejudice against the wood because of its great tendency to warp under old systems of drying. As placed on the market to-day its merits give it a recognized standing. The cut is estimated at between 150,000,000 and 300,000,000 feet.

Other Hard Woods.—Among other hard woods which have a place in commercial lists, birch, cherry, black walnut, maple, gum, sycamore and elm are cut for lumber, while there is a steady market for dogwood and persimmon for spool and bobbin stock. Birch is a common tree throughout the Alleghanies and the Northern lake region, the principal sources of supply being the West Virginia mountains, northern Michigan, New York, and Maine. Black birch (Betula lenta) is the principal species used. The growing popularity of birch furniture has increased its importance in the trade. Black wild cherry is widely distributed in the forests of the East, but the principal lumber supply is found in the mountain valleys of West Virginia and Tennessee. It is seldom the dominant tree over any extent of forest, occurring in mixture with other broadleaved trees. It is largely used in the manufacture of cabinet work and furniture. Black walnut, once common in the rich bench lands of the Mississippi basin, has been so largely cut as almost to have disappeared from market quotations. A considerable quantity yet remains in Kentucky, Tennessee, and Missouri, but it is now sold by the individual tree. Sweet gum is a tree of the swamps, and reaches its highest development in the Yazoo delta, Mississippi, and the swamp lands of Arkansas. It is a valuable furniture and veneer stock. Sycamore and elm are common in all the lowlands along the streams of the Ohio and lower Mississippi valleys. Maple has a greater Northern range than most of the trees of this group. It attains its highest development in the forests of Michigan. It is much used for flooring, furniture and interior finish. The annual cut of these hard woods of minor importance, although small for each species, in the aggregate equals nearly that of the leading commercial hard woods.

## THE ARMY OF THE CONGO FREE STATES.

ONLY a few months have passed since there was a great deal of talk of a military uprising, of the shooting of an English trader, Mr. Stokes, who had formerly been in the employ of the German Colonial Service, and of pretended plans for extension of territory in the Upper Nile region. Captain, now Major Lothaire, of the Congo army, played an important part in two of the above movements, but was specially prominent in connection with the shooting of Mr. Stokes. As these affairs have been referred to so much in all the periodicals of the day, and as so little is known of the military organization of the Congo Free States, even in military circles, some data relating to the subject certainly will not be without interest.

By the decrees of August 5, November 17, 1888, and of July 30, 1891, a troop was formed of Europeans—mostly men taken from the Belgian army—and natives, for the purpose of preserving quiet and order in the interior and maintaining the sovereignty of the government in districts where its influence cannot, at present, be exerted directly. In 1894 about $644,000, or nearly half of the budget, was set aside for this purpose.

This military organization is under the command of the governor-general of the Congo Free States and consists of: 1. The standing army. 2. The native militia. 3. The auxiliary troops. 4. The railroad auxiliary; and, finally, the free corps, placed in the Congo by the Anti-slavery Society of Brussels, which corps is expected to work shoulder to shoulder with the government troops.

1. The Standing Army.—All of the officers and the majority of the non-commissioned officers are European, and nearly all of the former—in 1894 about one hundred and fifty—were taken from either the active service or the reserve corps of the Belgian army. On their own application they were sent to the Congo for three years, but are still considered a part of the Belgian army, which supports them. Nothing is known definitely in regard to the number of non-commissioned officers nor to their relation to the Belgian army, nor is anything known of the value of the native soldiers, but, as they are taken from all parts of central Africa, they cannot constitute a uniform body. The natives of the Lower Congo have suffered much, morally and physically, from the slave trade of the Arabs and alcoholism.

Originally vacancies were filled by enlistment from all parts of the black continent, but since 1891 the yearly contingent has been determined by the King of Belgium and the troops raised, partly by enlistment and partly by drafting, almost exclusively among the natives of the Congo Free States. The number of men to be drafted is determined by the governor-general according to the number of vacancies left by volunteers. He divides the whole number among the different districts, taking men, as much as possible, between the ages of fourteen and thirty. The term of service is seven years, five years of which is spent in the regular army and two in the reserve corps. In 1889 the former consisted of only 2,000 men, 23 officers and 29 non-commissioned officers, but the force has been increased until it now numbers 5,000. However, the original organization of November 17, 1888—a staff and eight companies—has not been changed. The staff and the first company are stationed at Boma, the seat of government.

Each company is commanded by a captain and consists of several subdivisions, each of which is headed by a lieutenant or second lieutenant. The number of European and native sergeants and corporals depends on the number of men in the company. At first each consisted of only 100 to 150 combatants and 40 to 60 non-combatants, or 200 to 250 combatants and 40 to 60 non-combatants in the enlarged companies, but gradually the companies have been enlarged until the total number of men in the army has reached 5,000, as stated above. Each company has a standing garrison from which it supplies the service for the district under its charge. The four companies stationed farthest east, companies Nos. 4, 5, 7 and 8, are larger than the others. The garrisons are stationed as follows (see map):

Company 1 at Boma, for the districts of Boma, Matadi and Banana.

Company 2 at Lukungu, for the district of Stromschnellen.

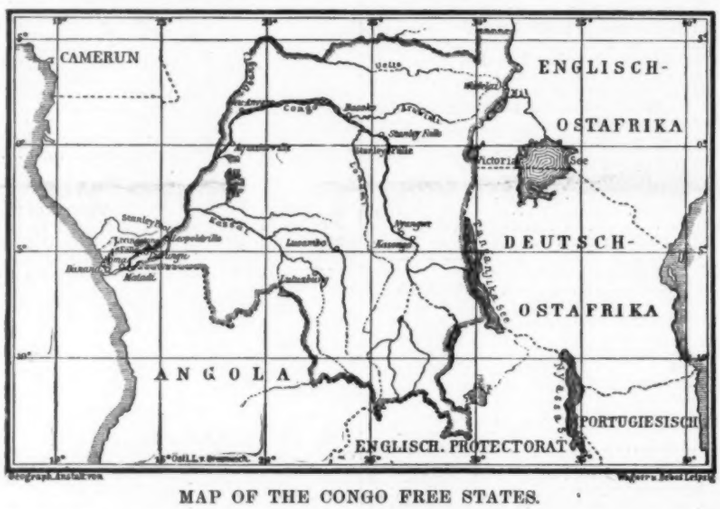
Company 3 at Leopoldville, for the district of Stanley Pool.

Companies 4 and 5 on the Upper Lomami, for the district of Lualaba.

Company 6 at Neu Anvers, for the district of Ubangi-Uelle and Equatorville.

Companies 7 and 8 at Basoko, for the district of Aruwimi-Uelle.

The companies at Leopoldville and Basoko supply the garrisons for Stanley Falls or Kassai.




MAP OF THE CONGO FREE STATES.

The troops are instructed by officers—one officer and two non-commissioned officers to each 100 men—for eighteen months, at the camps in Kinschalla near Leopoldville, Equatorville and Zambi (see engravings). Each camp is arranged for 500 men under a camp commander. The camps are protected against attack, but contain only light structures for shelter. Domestic animals are bred here and maintained on the neighboring plantations, for the purpose, on one hand, of supplying the necessary food for the men, and, on the other hand, of instructing the men in the care of them and farm work, a knowledge which will be useful to them after they leave the service. Our engravings show plainly the uniform, which is blue with red trimming at the neck and wrists, and the equipment, consisting of a belt, a cartridge bag, knapsack, saucepan, and tent covering, 6 feet 6 inches long by 2 feet 3 inches wide. Besides the suit of woolen material, each man is provided with one of summer stuff. The head covering is a red fez. The negroes prefer to carry their shoes on their guns rather than to wear them. Black leather leggings complete the uniform.

As for weapons, the officers carry the new Mauser gun and the men the old Albini gun. The number, construction and caliber of the guns given out to the companies vary very much. The men are paid 21 centimes (4·2 cents) per day, two-thirds of which is paid them in cash and the other third is allowed to accumulate until they are discharged.

All the storehouses are in Boma, where the troops are in camps similar to those for the recruits, but fortified. When free from duty they also are occupied with garden work. An attempt is made to have the discharged soldiers settle with their families in the neighborhood of the camp. The most important and the strongest camps are those at Basoko, Lusambo, Kasongo and Nyangwe. (See map.)

2. The native militia is composed of men levied, according to the requirements of the place, by the commander of that station, and divided into companies, but there is no exact information in regard to their numbers. They seem to be required more as carriers than for military service. They are very useful as auxiliary troops when expeditions are to be undertaken. For example, in 1893, the sixth white, consisting

of 300 regular soldiers, took 3,000 militiamen with them as carriers on the expedition to Kosongo.

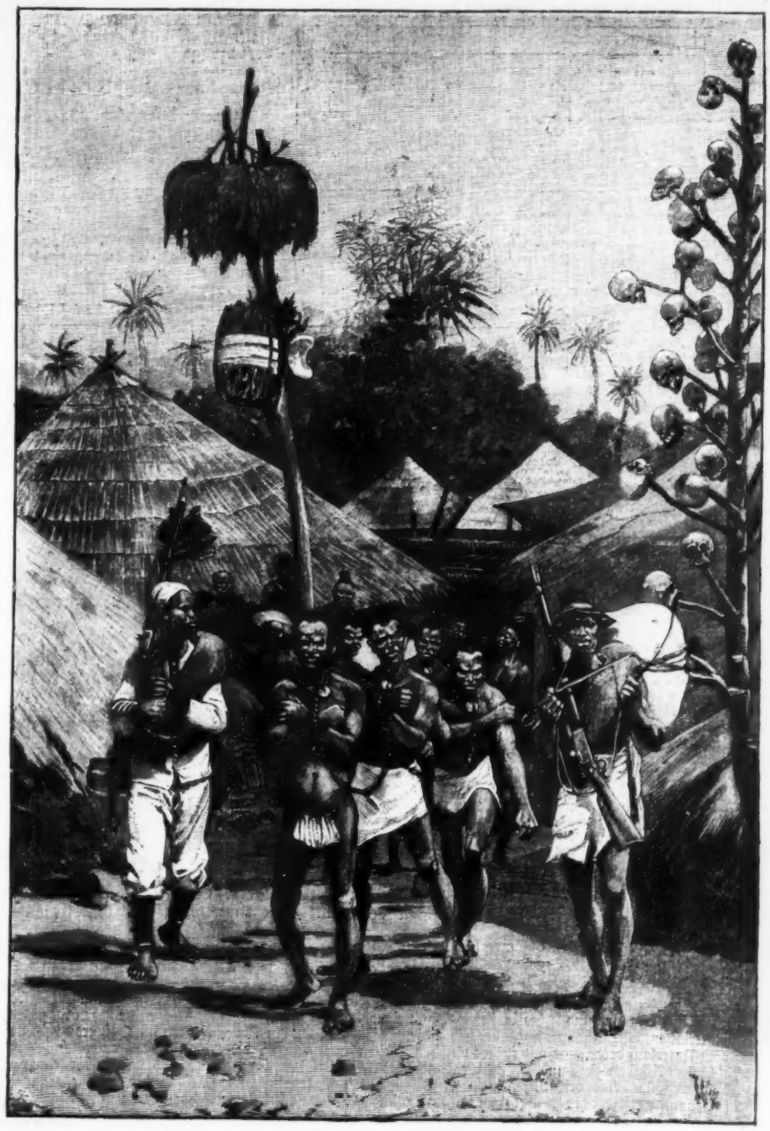
All attempts to use beasts of burden, even camels and elephants, have proved failures, but the waterways are used as much as possible and will be used still more after the completion of the 250 miles of railroad now being built between Matadi and Leopoldville, around Livingstone Rapids. The first 80 miles has been completed and already shows its effect on traffic.

3. Auxiliaries.—Whenever the safety of the interior is threatened, all civil officers and laborers form an auxiliary corps under the command of a military or a civil officer. Part of the workmen on the railroad form a corps for the protection of the property of the road and the rest form a reserve corps.

4. The free corps furnished by the anti-slavery society of Brussels has been stationed since 1888 in the country west of Lake Tanganyika to prevent the carrying of slaves to Zanzibar. The commanders are appointed by King Leopold and the men are, to a great extent, orphans that have been brought up by the missionaries, and freed slaves, with whom the society has settled a number of fortified posts in this region. The society has provided several cannon and two steamers on Lake Tanganyika.

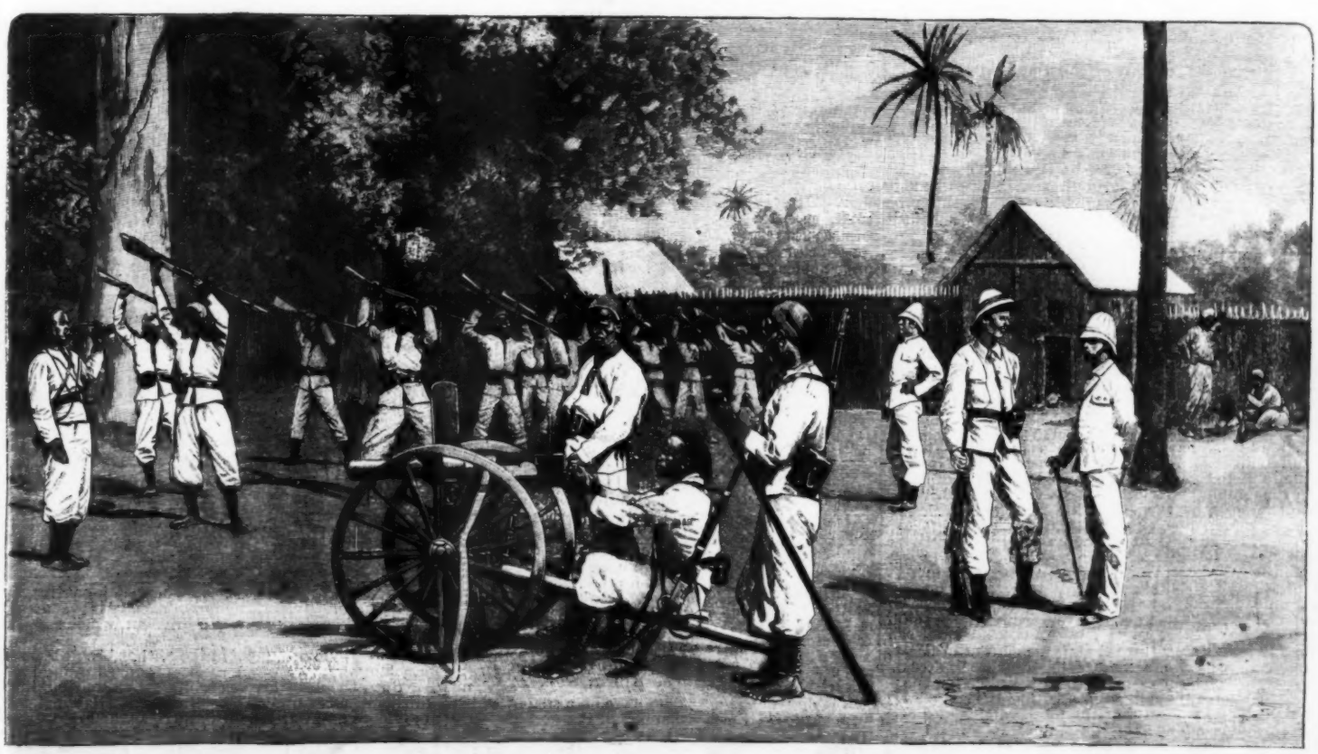
In closing, we will give an opinion, taken from a letter written by a civil officer of the Congo, in regard to the character of Major Lothaire, whose severe treat-

MAJOR LOTHAIRE.



Regular Infantryman. Militiaman.

TRANSPORTATION OF CAPTURED REBELS AFTER THE BATTLE OF LOMAMI.



Infantry. Artillery. Troops Drilling. Officers.

THE ARMY OF THE CONGO FREE STATES.—FROM SKETCHES BY A. WALD.

ment of the trader Stokes has caused an international dispute. He says that in his intercourse with Europeans Major Lothaire makes a most favorable impression, for he is good looking, has attractive manners and great energy and personal courage. These characteristics make him, perhaps, the most able officer in the Upper Congo, but if his authority is questioned, he will not hesitate to adopt the most severe measures. On account of his severe discipline he is much feared by the natives, who call him "Logembi" (the name of a much feared, warlike people in the south of the Congo Free States). Major Lothaire took a most important part in the suppression of the military uprising, and as a reward for his services on this occasion was raised to the rank of major. He was unable to travel on account of his wounds, but has been commanded by the governor-general of the Congo Free States to go to Boma as soon as possible to be present at the trial by the international court. His advocate left Lisbon on February 23, to meet him there.—Illustrirte Zeitung.

## PHYSICAL PHENOMENA OF THE HIGH REGIONS OF THE ATMOSPHERE.*

THE first and decisive cause of nearly all physical phenomena occurring in the terrestrial atmosphere is the solar heat. The atmosphere may, therefore, be considered an immense heat machine, of which the sun is the focus; the boiler is represented by the soil or the clouds heated by its rays, and the condenser by the radiation toward the interplanetary space.

The means by which physicists and meteorologists study the various regions of the atmosphere are very limited; they are obliged to content themselves, more often than not, with very indirect observations, and to proceed by induction. In fact, the most interesting phenomena occur in the high regions—that is to say, at almost inaccessible heights. The object of this lecture is to show by some experiments that meteorological physicists are beginning to approach very closely the real explanation of natural phenomena. You will see, in fact, that in certain cases, not only an exact image of these phenomena is obtained, but often a veritable synthesis of them may be produced by the employment of processes entirely analogous to those which really operate in nature.

I will begin by enumerating the means in use among meteorologists for studying the different regions of the atmosphere.

The most direct method is the use of the aerostat; the aerostat or balloon makes it possible to take instruments of measurement to the very heart of the atmospheric regions one wishes to study. Unfortunately the method is difficult, expensive, and also dangerous; it is, therefore, only used in exceptional cases. The balloon ascents which have resulted best are those of Gay-Lussac (1804), of Glaisher (1862), and recently of Dr. Berson, of Strassfurt (1894), who ascended more than 9,000 meters.

The most important facts observed in the balloon were very unexpected. Here is the resume of them:

(1) There exist very frequently clouds formed of crystals of ice; they constitute the cirrus, which float at very great heights.

(2) The direction of the wind changes at different heights.

(3) The temperature does not always diminish regularly with the altitude; very often cold layers and hot layers are met with alternately.

The second direct method for studying the atmosphere is the constructing of mountain observatories, as much as possible on isolated peaks. In these observatories the reality is daily verified of these unforeseen inversions of wind and temperature at different altitudes.

As for the clouds of ice, they are too high to be attained directly by the mountain observatories.

It will, perhaps, be interesting for you to know the principal mountain observatories constructed in France.

[Projection of the photographs of the following observatories:

| | | | |
|---|---|---|---|
| Pic du Midi | (altitude | 2,800 meters) | in the Pyrenees. |
| Mont Ventoux | " | 1,900 " | in Provence. |
| Puy-de-Dome | " | 1,900 " | in Auvergne. |
| The Eiffel Tower | " | 330 " | in Paris. |

This last observatory, owing to the lightness of its construction, entirely in open work, may almost be considered a captive balloon, permanent and fixed, three hundred meters above the ground.]

Halos.—We have said that mountain observatories do not attain the region of the clouds of ice (6,000 to 10,000 meters in altitude); it would, therefore, be only possible to observe them in a balloon. Fortunately, these crystals of ice reveal themselves by an optical phenomenon, the halo, which is even seen from the low levels. It is a brilliant circle, with radius of about 22°, which encircles the sun or moon; it has a reddish tint inside, and slightly bluish tint toward the exterior. It is explained, as well as many appearances of the same kind, by the refraction of the light of the body through ice crystals; in fact, the crystals of ice are hexagonal prisms, of which the faces are in pairs inclined at 60°. These crystals, disseminated in the air, and pointing in all directions, refract the light, but the refracted rays cannot exceed the slant of 22° which the minimum deviation discovered by Sir Isaac Newton imposes on them; the limit of the refracted rays is, therefore, a cone of 22° round the line which joins the eye with the sun or moon.

[Experiment Imitating the Halo.—Crystals are produced in a transparent medium, consisting of a mixture of appropriate liquids; in this way the mixture of hot and damp layers of the atmosphere is reproduced precisely, with the cold layers, which form the crystals of ice.

For this purpose a saturated aqueous solution of potash alum is placed in a glass cell, and through this cell a stream of light is made to pass, projecting the image of a circular opening representing the sun on a dark sky. Then a quarter of the total volume of rectified alcohol is added; the alum, insoluble in alcoholized water, is precipitated in very small crystals which float about in the liquid. The image of the sun is at first indistinct, as in a mist, but soon a brilliant circle, with delicate rainbow tints, appears, and represents exactly the appearance of the halo. The experiment is brilliant and instructive.]

This phenomenon is well known by country people; it is a sure sign of rain when it appears on a hot day, even if no other indications predict a meteorological disturbance.

Alternation and Inversion of Temperatures.—In neighboring observatories situated at very different altitudes, such as that of Puy-de-Dome and Clermont, the existence of hot currents is often noted in the high regions. It is to successive inversions of the same nature that Mr. Amsler, of Schaffhousen, attributes that beautiful phenomenon known in Switzerland as "Alpenglühen," and which consists of a second illumination of the snowy caps of the Alps some minutes after they had become dark by the setting of the sun.

[Projection of a photograph of the summits of the Bernese Oberland, the Jungfrau, the Monch, the Eiger; the view having been taken from St. Beatenberg, close to the lake of Thun. Picturesque imitation of the phenomenon by a colored glass and proper diaphragms.]

Mr. Amsler's explanation is founded on the change of the direction of the curvature of the trajectory of the luminous rays depending on whether the air at the bottom of the valleys is warmer or colder than that of the higher regions.

Before the setting of the sun the ground warmed by the solar heat imprints on the trajectory a curve analogous to that of the mirage, S A M B, that is to say, convex toward the earth (Fig. 1); the sun in going down, at S', throws the shadow of the summit A on summit B, which should, therefore, afterward remain in shadow, as the sun continues to set, and as the last ray is S' A M' B'. But if in the interval the air of the valley gets sufficiently cold, the trajectory takes an inverse curve, S'' A M'' B'', and summit, B, is again illuminated.

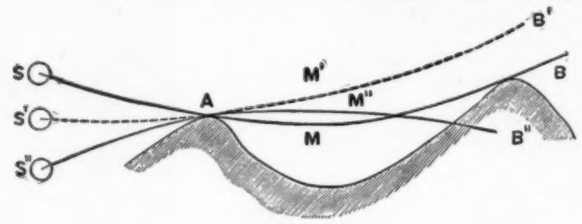



FIG. 1.

[Experimental Realization of the Inversion of the Curves of the Luminous Trajectories.—With a little care it is possible to superpose in a transparent cell of about 20 centimeters thickness three layers of liquid, of which the composition is given under Fig. 2. A movable mirror, L L, throws a stream of light through the opening, S, of a diaphragm. This beam of light, sent under different inclinations, is reflected either by the inferior layer of chloride of zinc (dense, but less refracting), or by the layer of diluted glycerine (lighter and also less refracting than the intermediate layer).

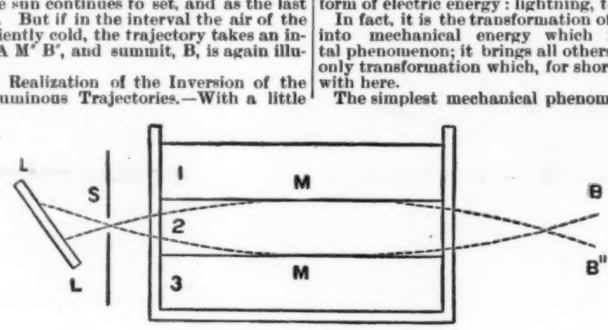



FIG. 2.

1. Glycerine 1/5, water 4/5. 2. Glycerine 2/3, water 1/3. 3. Anhydrous chloride of zinc 1/3, water 2/3.

A little fluorescence illuminates the trajectory of the streams of light, and renders their curves visible; the Alpenglühen can thus be represented with a few accessory arrangements.]

Scintillation of Stars.—This phenomenon is also a proof of the alternation of the temperature and of the movement of the layers of air in the high regions. Spectrum analysis shows that the scintillation is produced by a disappearance following a regular order (in accordance with a variation of the zenith distance of the star) of the successive colors of the spectrum.

[Imitation of the Phenomenon.—It is obtained by a very brilliant experiment, which consists in throwing the image of a luminous opening, O, with the help of a lens, L, on a little silvered ball, B, of 3 or 4 centimeters in diameter, resting on black velvet. Thus the aspect of a fixed star is obtained, with remarkable brightness (Fig. 3).

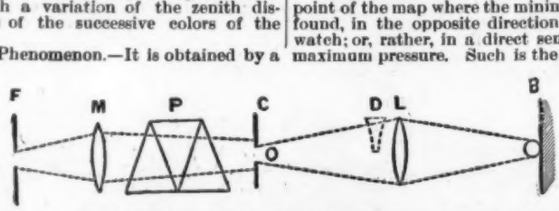



FIG. 3.—ARRANGEMENT FOR IMITATING THE PHENOMENON OF THE SCINTILLATION OF STARS.

But the luminous opening, O, is made in a card, on which is thrown the spectral image of a slit, F, which is dispersed by a direct vision prism, P.

In truth, the card, C O, is not in the focus of the spectrum, which focus is formed further off, in the plane of the lens, L. The result is that the rainbow image of the slit on the card has a white part in its center; it is there that the opening, O, is placed. Also the light thrown on the ball, B, is entirely colorless. But the beam of light, on coming out of the opening, expands into spectrum on the lens of projection, L, which recomposes it in B, as in a celebrated Newtonian experiment.

Then, by placing a screen with large meshes before the lens, L, certain radiations are taken away, and the star, B, appears colored.

A divergent half lens, D, with same focus as L, cancels its effect, and the spectrum of the star with the artificial bands created by the screen, appears on a white screen by the side of the ball. This is the imitation of the spectrum analysis of the scintillation of stars.]

It is seen by these few examples that the study of the optical phenomena of the atmosphere, aided by physical analysis and synthesis, can, and must, teach much about the calorific phenomena of the regions beyond our reach.

Dynamic Phenomena of the Atmosphere.—The phenomena studied up till now are due to conditions of almost perfect equilibrium in the atmospheric layers: they might be called static. But the calorific action of the sun, combined with the cooling action of radiation in space, can produce phenomena of movement representing every degree of intensity, from the feeblest to the most violent: we call these phenomena dynamic. They make themselves apparent in very different ways.

(1) Under the form of mechanical energy: winds, whirlwinds, cyclones, waterspouts, etc. (2) Under the form of calorific energy, which makes itself felt by the formation of clouds, rain, hail, corresponding to different changes of state of water, the element of the atmosphere which is continually varying. (3) Under the form of electric energy: lightning, thunder, etc.

In fact, it is the transformation of the solar energy into mechanical energy which is the fundamental phenomenon; it brings all others with it. It is the only transformation which, for shortness, I shall deal with here.

The simplest mechanical phenomenon which is produced in the atmosphere is the wind. The origin of the wind is the difference of pressure between two points more or less distant; since the time of Pascal, it is known that the pressure of air is measured by the barometer. It might be thought, according to this property, that the direction of the wind is always determined by the indications of this instrument; that the wind must go from the point where the barometric pressure is strongest to the point where the barometric pressure is feeblest.

Well, this is hardly ever the case. The real direction of the wind is always oblique to this theoretical direction. The fact has only been known a very few years; it is the general meteorological maps, suggested by Le Verrier about thirty years ago, and so universally known at the present day, which have put this fact beyond doubt.

The direction of the wind seems to turn round the point of the map where the minimum pressure is to be found, in the opposite direction to the hands of a watch; or, rather, in a direct sense round the point of maximum pressure. Such is the direction of the phenomenon in the northern hemisphere; it is contrary in the southern. In fact, the most ordinary movement of the atmosphere is a gyratory movement, which is called a cyclone.

The whirling movement of the air has been observed for a long time; we often see it produced around us. The dust, the dead leaves are lifted by the wind in a whirlwind resembling eddies in rivers. Sailors know of cyclones and waterspouts, and fear their dangerous effects. On the American continent there are terrible hurricanes, called tornadoes. These gyratory movements seem only to belong to great stormy perturbations; but the more the study of the atmosphere is followed in detail, the more it is seen that this kind of disturbance is met with in all manifestations of dis-

* Discourse delivered by Prof. Cornu, at the Royal Institution. (Translated by Winifred Lockyer and published in Nature.)

placed air. It is therefore concluded that the gyratory movement is to some extent the normal condition of agitated air; it would hardly be possible to employ force on a gaseous mass without developing more or less rapid rotations, which tend to acquire for themselves a permanent condition.

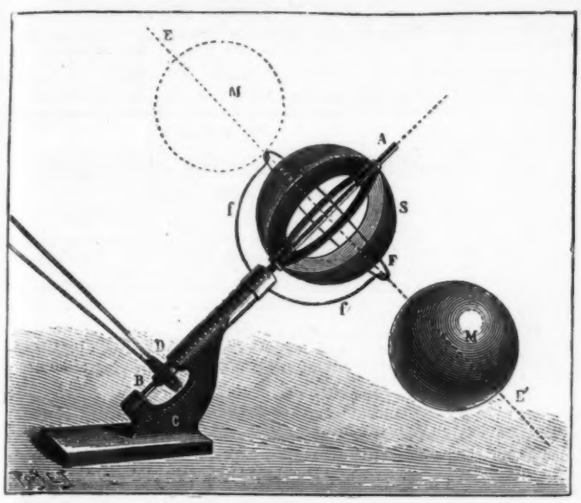



FIG. 4.—ARTIFICIAL REPRODUCTION OF THE GYRATORY NATURAL PHENOMENA.

FIG. 5.

Experimental Proofs.—Every time a rapid jet of gas is produced, one or more cyclonic movements are formed at the side of the jet. If the projected column is of a cylinder shape, the cyclonic movement will take the form of a ring; for example, the rings of smoke which are observed after the explosion of cannons, guns, etc.

[Repetition of the well known experiment of smoke rings, produced by striking the canvased end of a box filled with vapor of hydrochlorate of ammonia, with a circular opening on the opposite side. The smoke rings are rendered visible by throwing them in the line of a beam of electric light.]

Multiple Origin of the Gyratory Movements of the Atmosphere.—Nearly all the general causes which act on the movement of the atmosphere are gyratory influences; when once the movement is set going, it continues of itself, and sometimes increases in amount; in the first place, the movement of the rotation of the earth must be cited, which always brings with it a small component of rotation for a displacement of a gaseous mass in latitude or altitude; in the second place, and as decisive cause, the solar heat, which warms the air near the surface, or the clouds. As the ascending tendency of the heated gas cannot be equal over the whole surface exposed to the rays of the sun (as much because of the nature of the ground as because of its inequalities), the equilibrium is upset in certain parts, and gaseous columns ascend. This is, therefore, the same case as the jets, quoted above, and consequently under favorable circumstances for gyrations round horizontal axes. When once the gyration is established, the causes which have produced it keep it up and augment it.

The existence of whirlwinds with horizontal axes in hailstorms, particularly in that of May 20, 1893, at Pittsburg, has been observed by an American meteorologist, Mr. Frank W. Very, and has furnished him with a very ingenious explanation of the formation of hail. Indeed, such a whirlwind (if it has sufficient dimensions) takes the hot and damp air of the surface of the ground to high and cold regions; the vapor condenses, freezes, and crystals of ice are brought into the gyratory movement; they ascend and descend alternately, following the spirals of the whirlwind, and increase at every passage in the inferior regions, which are charged with humidity. This explanation accounts for all the peculiarities which are observed in a fall of hail: zoned structure, very low temperature, special sound before the fall, electric manifestations which accompany them; for a whirlwind of hail is a veritable influence electric machine, a sort of replenisher.

Artificial Reproduction of Natural Gyratory Phenomena.—The phenomena produced by the rapid rotation of the air are altogether unexpected, in consequence of the singularity of forces put in play. The ordinary laws of mechanics, to which daily experience has accustomed us, seem entirely different to those which the cyclonic movements seem to obey; and this must not astonish us. We have reduced mechanics to its simplest elements; the material point, the constant force, the rectilinear movement: thanks to these simplifications, we have been able to understand the movement of spherical projectiles, that of a pendulum, the rotation of a flywheel, etc. But as soon as the solid body becomes complex as to its form, when the movement which it may take has at the same time a translation and a rotation, our imagination represents it badly; if to this complication of form we add the resistance of the surrounding medium, then we have no idea of the probable resulting effect; for example, the boomerang. As to the movements of fluids, they are so difficult for us to foresee, that we receive fresh surprises every time we move a vessel of water; as soon as the mass of water is at all considerable, the tumultuous movements, which we unwillingly cause, always produce some awkwardness.

We understand then how impossible it is for us to anticipate the atmospheric movements, of which the mass is so immense, for each cubic meter weighs 1,300 grs.; if the energy expended in setting in movement such masses is considerable, inversely the stability of the system is enormous, since we have to wait for the dissipation of this energy by the passive resistances, almost always reduced to friction on the earth's surface.

We will, therefore, not endeavor to analyze the forces put in play in the gyratory movements of the air. I will limit myself to repeating before you some of the beautiful experiments of M. Ch. Weyher, who has been good enough to come himself to help me arrange the apparatus now before you.

Here is a sphere composed of ten circular paddles, put in rapid motion round axis A B (Fig. 4); the air caught in the rotation produces a general whirlwind movement, symmetric in relation to the plane of the equator. On all sides the air is sucked in by the revolving sphere, which may be seen by the effect on smoke or pieces of paper brought near it. This air is expelled from the equatorial circumference, and only in the almost mathematical plane of this circumference; in fact, look at these pieces of paper which keep themselves concentrically to the equator, following an arrangement which reminds us of Saturn's ring. The tension of the paper and its vibrations show that it is the repulsion of the equatorial outflow which maintains them.

It might be concluded from this, that the revolving sphere could only produce equatorial repulsions; but the complexity of the turbulent streams baffles the most evident anticipations. If a light balloon be approached a little distance from the sphere, it is immediately attracted, and begins to revolve rapidly round the sphere in the equatorial plain; if a second or third be let loose in the same way, they will follow it at varied velocity, and represent satellites; the planetary configuration is complete.

This paradox of a repulsion transformed into attraction by a change of form of the presented body is easily solved by considering the resultant of aspiring and repelling actions on the surface of the moving body. On the greatest angular space round the revolving sphere it is the whirlwind attraction which dominates. This is easily proved by placing underneath this sphere a basin full of hot water; if the atmosphere of the room is quiet, little by little the vapor will be seen to collect in a whirl from the surface of the water to the revolving sphere (Fig. 5). This is the imitation of a waterspout. The importance of this phenomenon has led M. Weyher to reproduce it in a more striking way, and by bringing into play a much more considerable quantity of mechanical energies, thus recalling better those which constitute this natural phenomenon.

The excitement of the gyratory movement (which, in nature, has its source in higher regions of the atmosphere) is produced by a small mill, placed three meters above a reservoir of water four meters in diameter (Fig. 6). When the small mill is made to revolve (400 to 500 revolutions a minute), the aerial whirlwind sucks up little by little the surface of the water, which is seen to be agitated and to be forming centripetal spirals, and producing a liquid cone several centimeters in height. Above this cone a great number of little drops accumulate, which fall back in spirals. This attraction, at a distance, is even more striking if the water is slightly heated; the vapor then forms a hollow tube, of which the hollow part is distinguished by its dark color and its geometrical regularity; it shoots forth from the water toward the small mill, causing light objects, such as bits of straw, which are floating on the liquid, to thrown up.

Such is the experiment which, in 1887, was made in the open air at the great works of the Weyher and Richmond Company. With the reduced apparatus, now placed before you (Fig. 6), we can repeat it in conditions quite as convincing. The small mill is placed at the top of the case two meters high, closed on one side by a glass; the water, slightly warmed and containing a little soap, is placed at the bottom of the case in a basin. I set the small mill going; you see the agitation at once, the soap bubbles precipitate themselves at the foot of the column of vapor. Soon the column takes the form already described, and represents exactly the appearance of a real waterspout; at the foot is the buisson—that is to

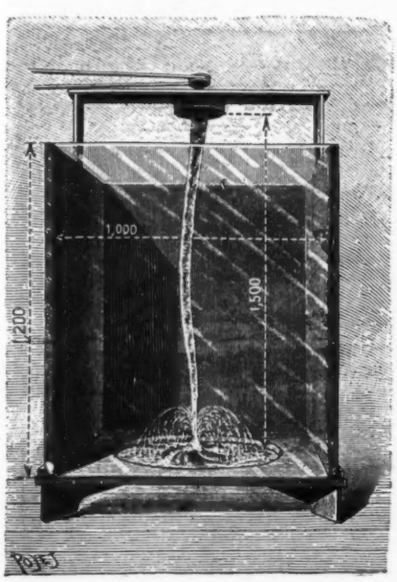



FIG. 6.—ARTIFICIAL REPRODUCTION OF A WATERSPOUT.

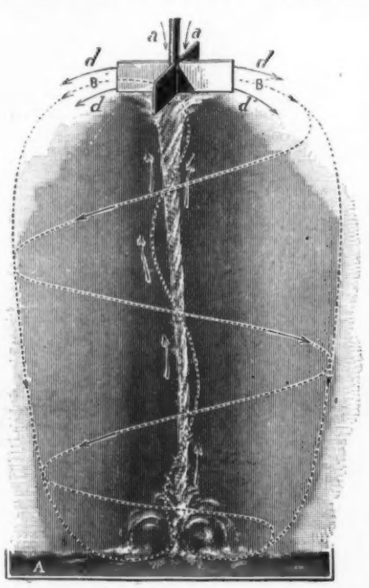



FIG. 7.—DOUBLE DIRECTION OF LIQUID CURRENTS IN A WATERSPOUT.

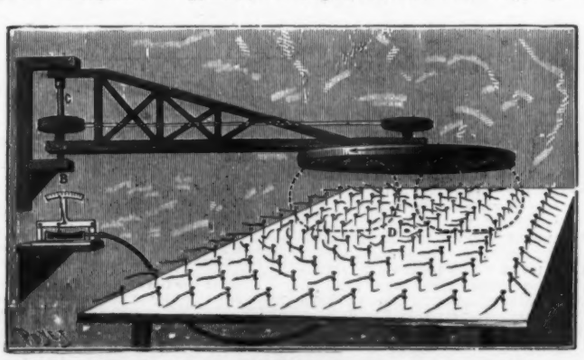



FIG. 8.—ARTIFICIAL REPRODUCTION OF CYCLONIC PHENOMENA.

say, the collection of bubbles and little drops; at the top, the expanded hollow tube of vapor. A light balloon placed at the surface of the water is first carried to the center and rendered captive at its foot; by quickening the rotation (which increases the power of the whirlwind) the balloon is raised by the waterspout, and sometimes follows the spiral the whole of its height.

The helicoidal movement of this light balloon, as well as the aspect of the nebulous spiral, shows well the constitution of the waterspout; one sees the superposed rolls of helicoidal currents, some ascending, others descending (Fig. 7); it is a perpetual going and coming between the mill and the surface of the water. As all the currents turn in the same direction if the ascending ones screw to the right, the descending ones screw to the left. It is the absence of having recognized this double movement of ascent and descent which is at the bottom of the misunderstanding between the partisans of ascending waterspouts and those who maintain that they are only descending phenomena.

The ascending movement of the light balloons caught up by the waterspout shows well the ascending velocities; it is more difficult to put in evidence the descending region, declared in some theories to be the only existing one, because it occupies in the reduced experiment a very small space; it is confined to the interior of the nebulous sheath, of which the hollow center is distinguished by its dark color. I will, however, show it to you with the help of a very simple artifice. Take a body emitting smoke to the top of the waterspout; we see this aspirated smoke at once reach the interior of the sheath, roll itself into a slender cone, and descend to the surface of the water. This is exactly what is seen in nature when, in a waterspout, the clouds descend in the form of a stream which grafts itself in the middle of the buisson formed by the water at the surface of the boiling sea. This spiral is, so to speak, the harmless part of the waterspout; the terrible part is invisible; it is formed by the mass of air which rages round the spiral. In the experiment before us it is contrary. The raging mass is visible owing to the smoke which is supplied; the interior of the spiral remains dark; it is by the introduction of the smoke that the existence and form are recognized.

There still remains to show you that with a similar arrangement a cyclone can be produced with all its characteristics—variation of pressure at its passage, barometric minimum, central calm, brisk rising of wind, center of storm, etc.—which has also been attained by M. Weyher.

The following remarks have been subsequently added to the lecture at the Royal Institution:

We will conclude by describing with some detail that experiment which reproduces so accurately all cyclonic phenomena. In reality a cyclone is nothing else than an immense aerial whirlwind; it only differs from a waterspout by its proportions, and principally with respect to the height and the diameter; in a waterspout the diameter is very small in relation to the height whereas in the cyclone it is the contrary. But in both cases the general movement is the same; the aerial currents descend all around, to remount immediately on the interior spirals, with a diameter more or less great, but leaving, as in a waterspout, a central region free, in which the descending movement is equally to be found.

Here is a flat rotating disk, about 1 meter in diameter, mounted on the extremity of a crane 2 meters in radius; by means of this arrangement it is possible to make the rotating disk travel horizontally above a large table in which are fixed a great number of pins, to the head of each of which is attached a bit of wool some centimeters in length, and thus forming many flags, which will show us the directions of the wind in each point traversed by the cyclone. In the center of the table a hole is pierced communicating underneath with a very sensitive barometer, which will show us the variations of atmospheric pressure at the passage of the meteor (Fig. 8).

We set the rotating disk in rotation after having placed it above one of the extremities of the table; you see at once all the flags situated underneath indicate the directions of the wind. Those which form the center of the whirlwind remain flat and rest inert on the table, their extremities directed one toward the other. They represent wonderfully well the central calm.

The flags surrounding the central calm form a circumference; they imply a wind forcing them all in a direction slightly centripetal, and ascending. In the following ranges the pieces of wool place themselves again along a circumference, but scarcely showing the centripetal direction, and not at all the ascending one; then the more distant the flags are from the center the more they inflect toward the table and indicate the descending wind; at the exterior circuit the wool takes centrifugal directions; it is air which escapes from all sides on the borders of the cyclone.

Now, if we make the artificial cyclone travel horizontally, by moving the crane on its pivot, you will see that the central calm shows itself every instant at a new place, which is very easily observed by the aspect of the flags occupying the center, which fall down suddenly and rest inert on the table. On the other hand the flags immediately adjacent raise themselves quickly, caught up by the tempest, and those which but recently were pointing in one direction turn all at once in the opposite one, and make it possible to observe with all its sharpness the abrupt change of wind which takes place on leaving the central calm.

By making the cyclone travel with sufficient quickness, the flags permit us to take note of the dangerous and manageable sides of a cyclone, according as one looks at the semicircle in which the wind turns in the same direction as the movement of translation, or in the opposite one.

The variations of pressure are indicated by the passage of the cyclone above the hole made in the table and communicating with the barometer; you see the needle falling little by little, indicating the minimum precisely at the moment when the center of the cyclone passes above the hole, then rising slowly.

A thermometer sufficiently sensitive, placed in the center of the cyclone, allows us to observe a rise of temperature.

In great cyclones, a ship on reaching the center not only finds a general calm, but the sun or stars may be seen to shine through a great opening in the clouds; it is the eye of the storm.

In order to explain this fact, it suffices to remark that a cyclone is only in fact a waterspout of enormous diameter, in the immense sheath of which rages the storm of a descending movement, dragging down the hurricane and the clouds from the high regions to the level of the sea; but, as in the waterspout, the central nucleus remains free, and allows a clear sky to be seen.

The realization of this eye of the storm succeeds equally well with steam or smoke by taking necessary precautions with the experiment.

Finally, as the center of the cyclone is free of water vapor (at least in the visible form), while in the enveloping sheath storm and darkness reign, is it not evident that a hygrometer placed in this cloudy sheath will show a degree of moisture above that of the central nucleus?

To sum up, it may be seen that, however small the scale of the experiments in comparison to that which passes in nature, nevertheless these experiments reproduce with fidelity and with all the particularities of the great natural meteorological phenomenon.

The experiments which you have just seen will, I hope, suffice to show you how complete the experimental syntheses are, and how they represent the natural phenomena in the smallest details.

I will conclude by making the simple remark that meteorology gains in extent and certainly when we treat it as an experimental science.

## THE WARING PLAN FOR THE SCIENTIFIC DISPOSAL OF STREET SWEEPING AND GARBAGE.

THE plan proposed by Col. George E. Waring, New York street commissioner, for the final disposition of street sweepings and garbage, commends itself at a glance to everybody who has given thought to the subject. His four specifications cover the whole field of operations with scientific clearness and completeness, and no one can doubt that if he is permitted to carry out his ideas, his success in this direction will be as great and satisfactory as it has been in the cleaning of the streets. His present propositions are, in fact, the culmination of his work, placing the finishing touches upon what all men are agreed in pronouncing the most perfect administration of a municipal department which this city has ever seen. His recommendations should be regarded in the light of what he has already accomplished. As an expert, his opinion must be accepted as outweighing that of all other persons.

(1) Garbage will be kept separate in such vessels as the board of health may prescribe, and will be collected by special carts.

(2) Ashes and dust (free from paper and other rubbish) will be kept within the house, or in the back yard, in special cans. From these they will be removed in tied bags by department men, who will stand them on the edge of the sidewalk.

(3) Street dirt will be placed in a bag (carried on a light truck) as fast as it is swept up. When the bag is filled, it will be tied and stood on the sidewalk. This system has been in use in Madison Avenue since last summer, and is now being extended. The ash carts will move slowly along the streets, with enough men attending to throw the bags into them as they pass. Thus, the shoveling of sweepings and the emptying of receptacles, as well as the standing of receptacles on the streets, and the collecting of sweepings into piles, with their attendant dust, litter, and nuisance, will be forever done away with.

(4) All refuse other than garbage, ashes, and dust will be kept within the house until called for by the department "paper carts," which will remove everything the householder wants to get rid of, from an envelope to a mattress or a cooking stove. These things will be taken to central depots, where everything of salable value will be separated, and all else will be cremated.

When this system is in complete operation, not only will the streets be clean, but they will also be tidy. Blowing papers and the dust nuisance will have disappeared. Furthermore, the $80,000 hitherto received by the city for the privilege of picking bones, bottles, rags, etc., during the trimming of the scows will be replaced by many times that amount received for the much larger quantity of material collected, and collection in much better condition. There are further possibilities, as to the use of unsalable paper for pasteboard, the development of steam for power by the burning of refuse, the use of ashes for making brick and concrete work. But concerning these we are not yet in a position to make any public statement.—Public Opinion.

## THE PARASOL ANT.

THE greatest known curiosity of insect life, so far as habits are concerned at least, is to be found in the "parasol" or "umbrella" ant. The common name by which the creature is known has been bestowed because of a queer habit this species of ant has of stripping certain kinds of trees and shrubs of their foliage and carrying the leaves to their nests. An army of these ants which have been off on a foraging expedition present the queerest sight imaginable as they march in long columns by twos, fours, and sixes, each holding the stem of a leaf in its jaws, the leaf itself shading the little insect's body like a parasol does the face and shoulders of a lady. The early naturalists imagined that these ants carried leaves for the sole purpose of protecting themselves against the rays of the tropical sun, but recent investigations show that they have another use for the bits of green they gather. The leaves, according to our authority, are only wanted as soil upon which to grow a certain species of fungi which the parasol ant is very fond of. The agricultural investigator mentioned above gives a detailed account of observation at a parasol ant's nest, where fungus growing appears to have been the chief industry.

THE University of California is to have a psychological laboratory.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